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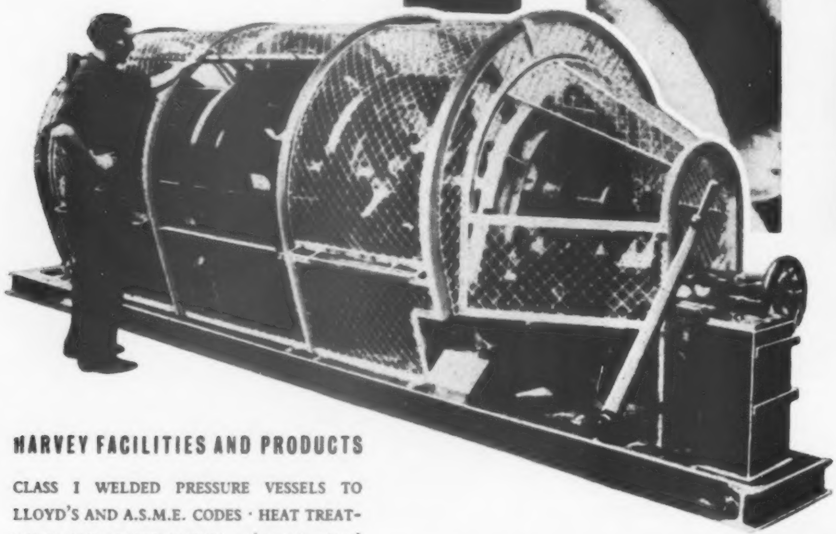

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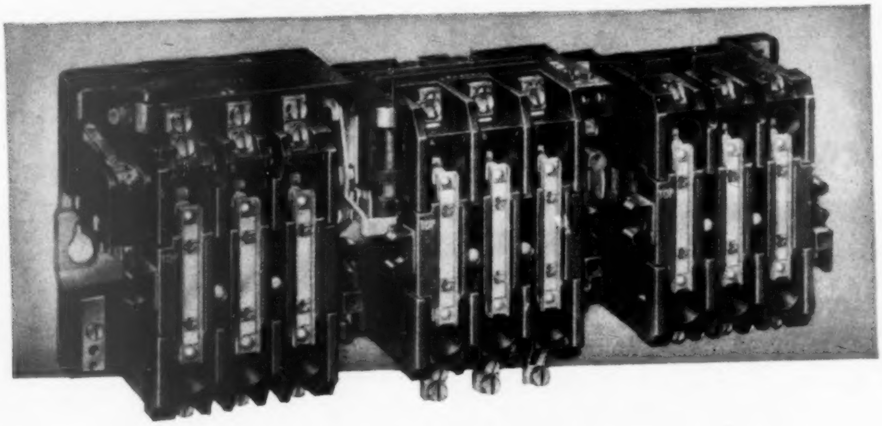

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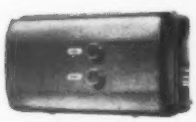
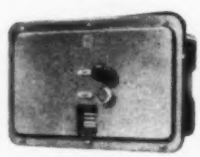
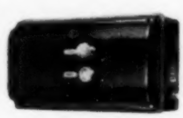


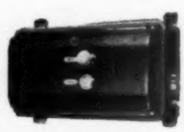
General Purpose



Flush Mounting



Heavy Industrial



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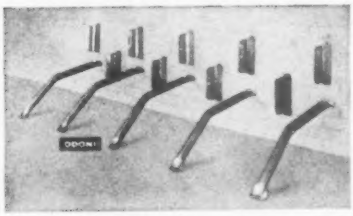

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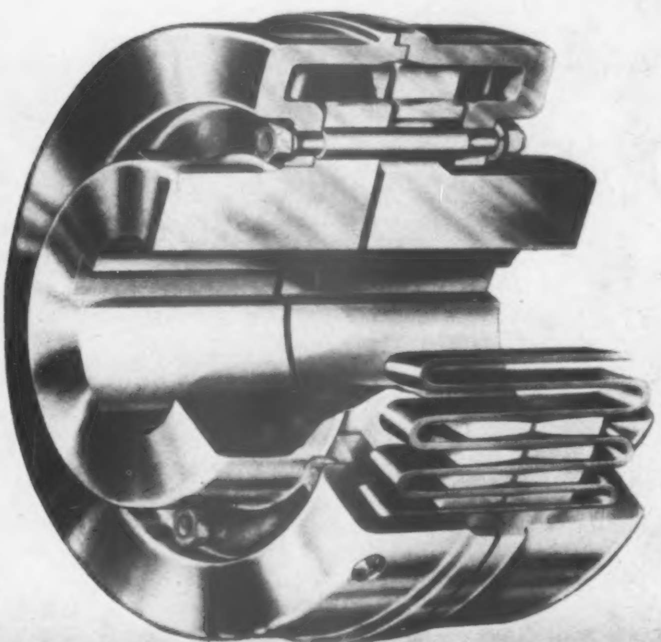

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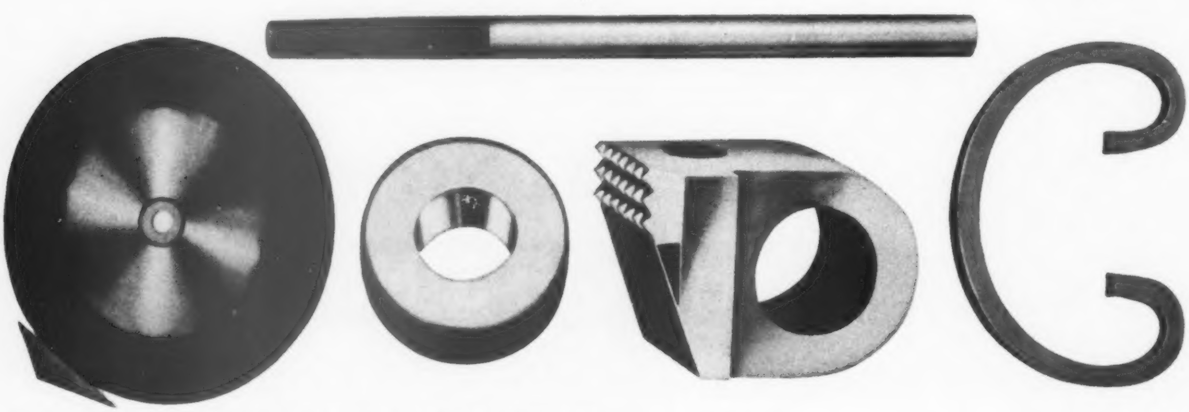

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The illustration shows the soldering of the winding to commutator risers of a 1250 kW., D.C. generator armature.

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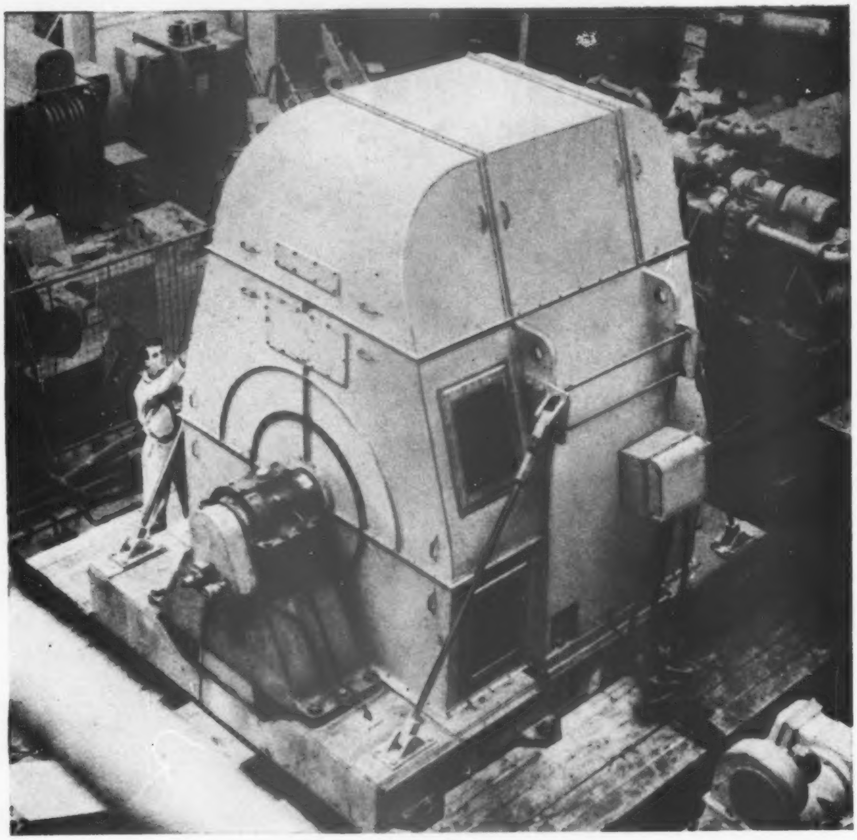

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Mechanical World — June 1962

English and Metric

OF all the ways in which the world is divided one of the most remarkable and probably the least political lies in the use of the metric and inch-pound systems of measurement. By and large the Continent is thought of in association with the metric system, and the English-speaking countries as users of the inch-pound system.

The question arises, in connexion with the Common Market, whether or not Britain should adopt the metric system, or at least should prepare to do so. The proponents of the change are the Common Marketeers and those who advocate a uniform world system and favour the metric system for the purpose. The British Standards Institution has examined the question and has recently made a statement of what to them would appear to be involved in making the change. Briefly, what is envisaged is a government pronouncement followed by three years of top-level consultations amongst industrial bodies, educational authorities, professional societies and institutions, trade associations and chambers of commerce, for initiating the change and preparing a national plan, the while the B.S.I. prepares a plan for revising some 1500 standards. This is followed by two years in which major bodies and individual companies work out their own programme while stocks are run down and new designs initiated, and while the B.S.I. recruits and trains additional staff. The next ten years sees the revision of the Standards and the appearance of metric designs, and a final five-year period would be employed "to convince laggards they must move with the times".

The final recommendation is that at the end of the total twenty years of change-over, "a date should be set for making inch measurements non-preferred"—a statement which implies that even in twenty years time the inch will be far from forgotten.

So far as Britain is concerned (and the same must apply in the other "inch" countries) the millimetre has been familiar in engineering since the beginning of this century at least—in fact, certainly longer for a table of metric conversion factors appeared in the 1893 edition of the "Mechanical World Year Book". Over the same period there has hardly been a set of British or American-made lathe change-wheels without the wheel required for cutting metric threads. And the catalogue with dimensions in both English and metric sizes has not been unknown. Engineers' rules marked in both millimetres and inches, micrometers for one or the other system, and sets of spanners similarly distinguished have been commonplace in tool shops and tool catalogues for as long as living memory serves. These are not academic phenomena but symbols of the variety of the world's work that passes through British workshops.

Chemistry is certainly more thorough-going for the metric system than is engineering, which at most is bi-system. Chemistry is taught in grammes and millimetres and these are the quantities of industrial chemistry. And the chemical industry is all for "tonnes".

Pure science in general, of course, is well settled with the metric units.

Altogether, it seems that for the larger sections of British industry the half-decision of making inch measurements non-preferred could be taken at any time, if it should be found desirable. That will be if and when metric standards become so widely used—by choice—that inch standards become obsolete. This presumes the preparation of metric standards as and when they are required, which is the usual course, for standards arise out of practice.

LOG SHEET

Blue Streak

Now that many of the European nations have agreed in principle to join a European Launcher Development Organisation, as proposed by the British and French Governments, the future of the British Blue Streak rocket in a space role would seem almost assured.

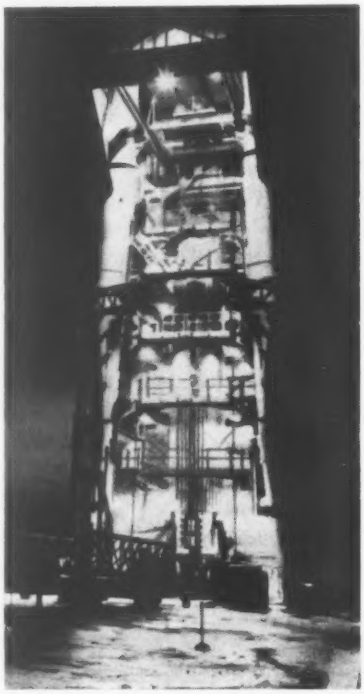
Blue Streak, which is fabricated at the Hatfield works of The de Havilland Aircraft Company Limited comprises a cylindrical structure, 10 ft dia, divided into three bays or sections with an overall length of 61 ft. In the propulsion bay are fitted the two Rolls-Royce RZ2 engines, which between them can develop 300,000 lb thrust, together with the hydraulically actuated jacks that move the engines on their pivot mountings during flight, thus allowing the vehicle to be steered. Also in the propulsion bay are gas and lubricating oil containers and other ancillary equipment. The tank bay holds the propellants while the third bay holds instruments and transmitters.

The 46 ft tank bay is divided in two; the top part furthest from the engines holds 60 ton of liquid oxygen and the rear part 26 ton of kerosene. The oxygen is carried through the kerosene tank to the propulsion bay by a double walled pipe. The tank is fabricated mostly from Firth-Vickers Staybrite FSM 1, 0·019 in. thick. The handling of such a light structure of these dimensions necessitates the utmost care and precaution through all stages of manufacture, and more especially after completion when, to minimize skin buckling during ground handling, a pressure of 2—5 psi of nitrogen is kept in the tanks.

The stainless steel arrives at Hatfield in 36 in. wide reels. The lengths required for cylinder construction are cut off diagonally, wrapped on a sizing wheel and butt welded. They are then placed on a roller bed and backed by a spot welded strap. To keep a true cylindrical shape, temporary stabilizing rings are fitted, both on the inside and outside. The rollers are precision built and laid on a 6 ft concrete anchorage for rigidity. In this position the rings are welded together with the aid of a pneumatically operated expanding mandrel.

The end domes, three to each rocket, are fabricated from twelve curved panels, stretch-formed on a Hufford machine and fabricated on a jig frame, adjustments being made on the last panel left oversize for the purpose. Welding the external stringers required special machinery. The 46 stringers attached to the kerosene tank are located in position through gaps in the outer temporary rings. The welding units are mounted on trolleys to travel the length of the tank, wih the back-up electrodes running on a carriageway on top of a 24 ft boom inside the structure. Contact between the operators is maintained by microphone and headsets.

Final assembly takes place on the handling frame, which remains with the vehicle until it is transferred to a test stand. For the next stage of fitting out the motors, the rocket is transferred by low loader to The de Havilland Aircraft Company's Stevenage factory. Here, again, loading is simplified by the handling frame. By the use of two fixed gantries, each having King 10 ton Mammoth electrically operated hoist, the completed vehicle is lifted, and the low loader backed beneath.



Blue Streak is located on the launcher pad for captive firing test

Captive firing tests are carried out at the Spadeadam Rocket Establishment, Cumberland. The handling frame is hinged to the launcher pad, and the complete assembly hoisted into the upright position by Marvex chain blocks. Blue Streak is then removed from the handling frame and suspended from a King overhead crane specially built for this duty and having creep speed on all motions.

Water Cooled Power Cable

High voltage power cable that is internally cooled by circulating water, a product whose development has been pioneered by Associated Electrical Industries Limited, is to be installed for the first time in a power station. The No. 4 120 MW generator at the Central Electricity Generating Board's Bankside Power Station is to be connected to its generator-transformer by this type of cable, and a complete water-cooling system for the connections is to be supplied. Water-cooled power cable was originally developed by AEI in conjunction with a project to increase the output of the Glasgow University synchrotron from 300 MeV to 450 MeV.

The Bankside project is significant when viewed alongside the tendency towards concentrating electrical power generation in larger and larger units. As the rating of generators increases, it becomes more difficult to provide a satisfactory connection between the generator and generator-transformer. Where currents as large as 10,000-20,000 amp have to be carried, conventional cable systems are quite out of the question owing to the large numbers of cables required, and the fact that their current carrying capacity is reduced by mutual heating.

Water-cooled turbo-generator stator windings (also pioneered by AEI) are already an essential feature of very powerful turbo-generators and this new development offers the possibility of a common hydraulic circuit which might eventually embrace water-cooled transformer heat exchangers. In a normal installation, the solution is based upon the method used by AEI Turbine Generator Division for terminating water-cooled generator stator windings. The resistivity of water is such that a water feed circuit of sufficiently high resistance to keep leakage

current at a tolerable level can be devised between the HV conductor and the earth potential water supply. Thus a PTFE tube, of suitable length and cross-section may be used at the entry and exit points to give a column of water of sufficiently high water resistance. It is possible to design these tubes so that water resistivity can fall to around 15,000 ohn/cm³ before the power losses in these tubes reach undesirable proportions. In the case of the sealing ends for Bankside the water feeds are in the form of channels inside the wall of the porcelain sealing end itself, the bottom end being brought out of the gland by a suitable union. The high voltage ends of the channels are connected to the water duct in the cable via a copper stalk compressed on to the conductor. To prevent water leakage, the end of the polythene insulation is bonded on to the copper work by means of a polythene injection moulding.

Slip Gauge History

The origin of slip gauge manufacture in Great Britain was described recently by Mr. H. A. Johnson, managing director of F. J. Edwards Limited of London, makers of the Besco sheet metal working machines. It happened in the 1914-18 war when the late Mr. Edwards, who was marketing can-making and sheet metal working machinery, became associated with Mr. Johnson with the purpose of Mr. Johnson's setting up a works to make slip gauges which had by that time ceased to be available from Sweden. Mr. Johnson had been engaged in the tool-making business and had every confidence that he could make them. What was lacking was a sufficiently accurate means of measuring them.

However, following a contract to manufacture from the Ministry of Munitions it was arranged for each set of 81 gauges to be examined and certified by the National Physical Laboratory, and sent on from there to the various government controlled factories where check gauges were required.

Now, more than 40 years later comes a pleasant sequel to the story. In February of this year the N.P.L. presented to Mr. Johnson a set of his slip gauges with the citation, signed by Sir Gordon Sutherland, N.P.L. Controller, that "This 81-piece set of slip gauges

Mr. Johnson with one of his sets of slip gauges made during the 1914-18 War. The set has been presented to him as a souvenir by N.P.L.

was manufactured by Messrs. F. J. Edwards Limited, and supplied over 40 years ago to the National Physical Laboratory, where it was in use for many years." Accompanying the gift were photoprints of some of the original early certificates issued for gauge sets made by Mr. Johnson.

Fasteners Corrosion Laboratory

The G.K.N. Fasteners Corrosion Laboratory at Birmingham concentrates in one laboratory and expert staff all the knowledge and investigational work on corrosion which had previously existed scattered in various companies. The laboratory is on the premises of Fredk. Mountford (Birmingham) Limited.

In addition to the normal laboratory equipment, there is a comprehensive range of specialized equipment for use in all aspects of corrosion technology, which includes a humidity cabinet capable of operating at a wide variety of humidity and temperature conditions to simulate differing types of tropical exposure; a test cabinet specially designed for use in corrosion tests with modified salt-spray solutions, e.g. those containing acetic acid with or without the addition of copper chloride. Salt-spray tests have been developed to produce, rapidly the type of breakdown encountered, in actual service, of nickel-chromium electrodeposits.

Other specialized equipment includes a furnace for heat treatment of materials in order to assess the effect of such processes on corrosion resistance. There are also space and facilities for assembling and building special apparatus to carry out any unusual test programmes which may be needed.

The main lines of development and investigation work at present in hand are a very full series of tests, comparing the performance of numerous materials and finishes under a variety of corrosive conditions, and the effect of various timbers and conditions of service on a number of materials and finishes.

Fafnir Bearings

The Fafnir Bearing Company Limited, of Wolverhampton, a subsidiary of the U.S. company of the same name, has built a new factory at Hednesford, Staffordshire, a few miles from Wolverhampton. The new building, which was opened last month by Mr. Erroll, President of the Board of Trade, has only one permanent wall, the other three being made of 22 gauge industrial aluminium sheeting which can be readily dismantled for extension of the building. Stability of air temperature and humidity, important in bearing manufacture, are secured by an air changer and steam heating.

In 1961 the company packed 7,000,000 bearings and increased their exports by 60%, which accounted for 16% of their total turnover. They have a labour force of 1,300 at Wolverhampton and will eventually employ 600 at the new Hednesford factory.

Reprographic Technology

The Institute of Reprographic Technology is a new professional body with entrance by examination so that its members can become qualified in knowledge and experience not only in the techniques themselves but in the management of reprographic departments. Aims are similar to the aims of other professional bodies, and may be summarized as being to increase the efficiency and technical ability of those practising the art of reprographic technology, and to give them a status which their knowledge and ability demands.

The chairman is Mr. Charles Hanrott and the address is 157, Victoria Street, London, SW1.

Magnetic Particle Seals

A flexible membrane consisting of finely divided iron particles suspended in oil and constrained in an air gap by a magnetic field is capable of providing an efficient shaft seal for stationary, rotating or reciprocating actions. The seal is self-adjusting to shaft displacement due to bearing wear and also eliminates wear in the gland itself. Breakdown pressure is proportional to the gap flux density, and also dependent on shaft speed in rotary applications

THE use of magnetic particles suspended in a magnetic field offers a new type of seal for rotating shafts, reciprocating shafts and stationary applications with a number of advantages over conventional mechanical seals—notably in absence of wear, lack of maintenance requirements and considerable flexibility as regards self-adjustment to shaft displacement due to bearing wear or other causes. Its conception stems from the development of the magnetic particle clutch where one of the major problems was to prevent leakage of the magnetic fluid at the bearings. Since this fluid consists, basically, of finely divided iron powder suspended in oil it appeared logical to employ a permanent magnet 'guard' to restrain the fluid medium within the limits of the bearing housings. It was found that this did, in fact, work and that particles trapped by a radial magnetic field effectively formed a flexible membrane around the shaft preventing fluid loss. Such promising results led to further investigation of the behaviour of iron particles in oil constrained by a magnetic field as practical forms of shaft seals.(1)

The basic design of a magnetic particle shaft seal is shown in Fig. 1. The necessary magnetic field can be provided either by a wound coil or permanent magnet, the latter obviously offering the simpler solution. The most logical form for the magnet is a circular ring surrounding the shaft with pole pieces at each end providing a closed loop for the flux path through the shaft via two small air gaps. The shaft must, of necessity, be of ferromagnetic material to complete the flux path, the strength of the magnetic field being governed by the strength of the magnet, the iron losses (through pole pieces, shaft and joints) and losses at the air gaps. The housing accommodating the magnet and pole pieces must be non-magnetic to prevent flux loss through leakage.

If a magnetic fluid is then introduced at one of the air gaps it will be restrained in position by the magnetic field in this gap. A suitable magnetic fluid consists of a mixture of carbonyl iron particles and low vapour pressure oil which, in the magnetic field, appears to take the form of an iron particle 'lattice' with the interstices sealed by the oil. This forms, in effect, a mechanical membrane which is impervious to air or gas leakage from one side of the seal to the other. At the same time the membrane is flexible in that a difference in pressure will cause it to deflect sideways, the limit to the membrane's performance as a seal being set by that pressure at which the mechanical structure collapses or is disrupted.

In the form so far described we have a stationary magnetic particle seal. The differential pressure loading or 'sideways force' which the seal can withstand is proportional to the strength of the magnetic field locating the magnetic fluid 'membrane' in the air gap. Above a certain minimum gap flux density (around 500 gauss) experimental results have determined that the relationship between breakdown pressure and gap flux density is substantially linear and given approximately by:-

$$\text{Breakdown pressure (psi)} = \frac{25 \times \text{flux density (gauss)}}{1000} - 10$$

Basically, therefore, to realize any required sealing pressure it is only necessary to increase the gap flux density to the necessary level (e.g. by selection of permanent magnet material and gap dimensions). However, this will also impose a similar increase in force on the shaft itself, resisting motion, if the seal is to be used

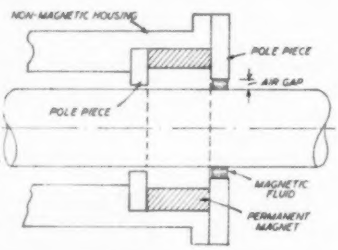


Fig. 1.—Basic arrangement of magnetic particle shaft seal

with a rotating or sliding shaft. Assuming that this force or resistance to motion will be independent of shaft speed the following empirical formula (2) has then been derived as typical of the power loss generated by a magnetic particle seal:-

$$\text{Horse power absorbed} = \frac{25 \times \text{rpm} \times F \times L \times D^2}{10^6}$$

where L = axial length of seal in contact with shaft (in.)
D = diameter of shaft (in.)
F = an empirical load coefficient expressed in terms of force per unit area of seal in contact with the shaft (psi)

Values of F can only be determined by experiment, typical performance being shown in Fig. 2. The relationship is non-linear, showing a proportionately higher increase in F with increasing gap flux density. Higher sealing pressures, therefore, are only realized at the expense of an increasing power loss in the seal itself. However, typical figures compare quite favourably with losses experienced with conventional mechanical oil-seals for normal low pressure ratings. Some typical worked out calculations are summarized in Table I.

Under rotation, however, the static sealing ability of the magnetic seal is modified. The original lattice structure is disrupted by churning, yielding to a vortex-

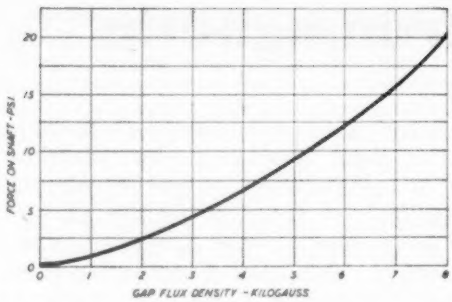
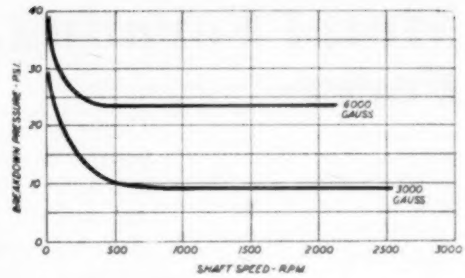


Fig. 2. (left)—Typical performance values of load coefficient F

Fig. 3. (right)—Characteristic of breakdown pressure with speed and gap flux density



type motion of the fluid constrained by the magnetic field and a radial velocity gradient of particles. The result is a lowering of the breakdown pressure, dependent largely on the original gap flux density and the rotational speed of the shaft. Basically, however, this loss of breakdown pressure follows a definite and typical pattern consisting of a fairly substantial initial loss followed by a constant performance with further increase in shaft speed (see Fig. 3). The initial loss is the result of the breakdown of the membrane lattice into vortex motion which apparently reaches a stable state at a certain shaft speed and the higher the gap flux density the quicker this constant state is reached (i.e. the lower the shaft speed at which the breakdown pressure curve becomes horizontal). At the same time, as would be

Table I.—CALCULATED PERFORMANCE OF MAGNETIC PARTICLE SEALS AT GAP FLUX DENSITY OF 1000 GAUSS*

Shaft Dia.	Shaft Speed	Force on Shaft	Power Absorbed
in.	rpm	lb	hp
1	1000	0·52	0·0042
,,	2000	,,	0·0084
,,	3000	,,	0·0125
2	1000	1·04	0·017
,,	2000	,,	0·034
,,	3000	,,	0·050
3	1000	1·56	0·0375
,,	2000	,,	0·075
,,	3000	,,	0·1125
4	1000	2·08	0·045
,,	2000	,,	0·090
,,	3000	,,	0·136
5	1000	2·6	0·104
,,	2000	,,	0·208
,,	3000	,,	0·312
10	1000	5·2	0·42
,,	2000	,,	0·84
,,	3000	,,	0·125

*Equivalent to a breakdown pressure of approx. 15 psi for stationary applications, or approximately 5 psi for rotary applications.

expected, the higher the gap flux density to start with the stronger is the vortex pattern, resulting in the least difference between static breakdown pressure and constant dynamic breakdown pressure.

Essentially these relevant performance figures can only be determined exactly by actual test. It has been established that the size of the air gap has little effect on breakdown pressure over a clearance range of up to about 10 thousandths of an in. but larger gaps do progressively lead to a deterioration in performance. As a rough rule, a clearance gap of less than 10 thou. is not necessary, but larger gaps would require a corresponding increase in magnetic flux in order to achieve a comparable performance.

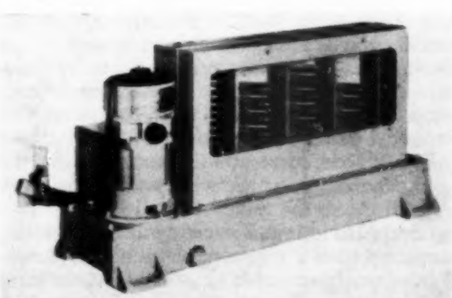
From these data it can be seen that the magnetic particle seal is most effective as a stationary seal where quite high breakdown pressures can readily be achieved within the limits of standard permanent magnet performances. As a rotating shaft seal, practical breakdown pressures realizable are considerably reduced, if excessive power loss is to be avoided. The higher the magnetic sealing force, too, the greater will be the heat generated, capable of causing a noticeable rise in temperature in the shaft adjacent to the seal. On the other hand this is not accompanied by wear on the shaft or deterioration of the seal (as would normally occur with mechanical seals). Within the range of normal low pressure mechanical seal applications the frictional loss is at least comparable with, if not favourable to the magnetic particle seal, as can be seen by extracting comparative figures from Table I.

Methods suggested for improving the efficiency of the magnetic particle seal for rotary applications include tapering the pole pieces to provide a non-uniform magnetic field 'biassing' the sealing fluid against a pressure load; two or more separate seals progressively to drop the pressure (and thus increase the overall breakdown pressure); and special designs to utilize centrifugal force as well as magnetic force to maintain the form of a suitable sealing membrane. Considerable possibilities also exist for utilizing magnetic particle seals on reciprocating or sliding shafts or members with automatic adjustment of the seal to slight lateral movements.

Basically, the magnetic particle seal must still be regarded, largely, as in the experimental stage of development although its performance is undoubtedly promising enough for it to be seriously considered for production designs ([3]). Essentially, too, it has only so far been investigated as a seal for air or gases. There appears every possibility that it could prove equally effective for sealing water, aqueous solutions and oils under pressure, bu performance in the field of liquid sealing has yet to be evaluated.

References

([1]) AEI Research Laboratory, Manchester.
([2]) J. W. Walley.
([3]) British Patent No. 783881.



PULSING MACHINE.—A special purpose device which forms part of the G.P.O. trunk dialling system equipment. It comprises cam-operated contact assemblies, driven at constant speed, which produce gated impulses. These machines, of which a number have been supplied by Laurence, Scott & Electromotors Limited, Norwich, must be capable of operating for long periods without maintenance

Metal Forming by Electromagnetic Force

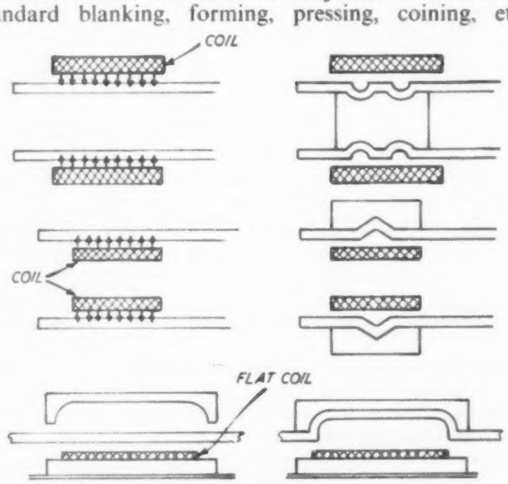
Utilizing microsecond pulses of magnetic force electromagnetic forming machines can be used to swage, expand, compress, coin, shear or assemble sheet metals up to about 16 swg thickness without mechanical contact with the workpiece. Working pressures of 50,000 psi are currently realized with a standard production machine developed by the General Atomic Division of the General Dynamics Corporation from experience gained in working with high-intensity magnetic fields as part of a controlled fusion (thermonuclear) research programme carried on since 1957. The electroforming machine utilizes standard line voltages, the required energy being obtained from a capacitor bank. Adaptable for the forming of all metals in sheet or tube form, those with low conductivity may require the use of 'drivers'. Electromagnetic forming machines are readily automated, require minimum maintenance and are suitable for rapid repetitive work

METAL forming by magnetic rather than mechanical pressure has now been developed to the stage where it appears as an extremely versatile and practical engineering tool permitting forming, swaging, blanking, and other forms of presswork to be carried out without employing moving parts in the forming machine, or mechanical contact between the forming tool and the workpiece. The necessary work force is generated purely by magnetic repulsion—a pulsed, high-intensity magnetic field produced by a work coil inducing a current in a workpiece of conductive material in close proximity to the coil which reacts with the coil field to produce a force on the workpiece. Working pressures as high as 50,000 psi are readily achieved by this method In fact, in practice the magnetic field pressure is limited only by the desirable fact that it should not exceed the compressive strength of the coil material. If this is not important—i.e. the coil is regarded as having a strictly limited life—field strengths of the order of a million gauss can readily be achieved, eqivalent to a magnetic pressure of something over 500,000 psi.

The basic working principle involved is, quite simply, that of producing the necessary magnetic field strength consistent with the working pressure required. The saturation field strength of the best ferromagnetic core materials is about 20,000 gauss with an equivalent magnetic force of the order of 300 psi. Materials capable of considerably higher 'saturation' have been produced in the laboratory, but only in very small volumes. Even so the level of magnetic force produced is still well below the work capacity needed for metal forming.

The solution adopted is, therefore, to employ a pulsed magnetic field generated by discharging a capacitor through a coil over a period of microseconds. In this manner a flux density of the order of 300,000 gauss can readily be achieved, corresponding to a pressure of 50,000 psi. Field penetration of the workpiece is limited by the short duration of the pulse (usually about 10 to 20 microseconds) to minimise energy losses. In terms of work-capacity such a magnetic field is capable of doing 7400 ft lb of work per cubic in. of field. At the same time the field may be concentrated or relieved at definite points by the use of suitable pole pieces or field shapers, if necessary.

Three basic coil arrangements are shown in Figs 1, 2 and 3. With the coil surrounding the workpiece a collapsing pressure is exerted, particularly suitable for swaging or crimping operations. If necessary, field shapers can be used to concentrate the collapsing pressure at specific points or bands to conform to the shape of an internal fitting. With an internal coil an expanding force is produced capable of enlarging the diameter of a tube along its length or forming the walls into a shape governed by an external bushing or fitting, etc. With a flat coil used in conjunction with a die, standard blanking, forming, pressing, coining, etc.,



Figs. 1, 2 & 3 (top to bottom) basic coil arrangements

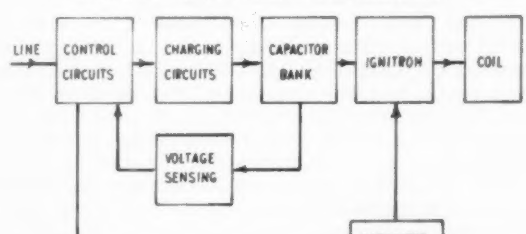


Fig. 4.—Typical charging and control circuit

is possible, governed only by the area of the coil and its work capacity.

The workpiece must, of necessity, be of conductive material so that eddy currents are set up in the surface to confine the magnetic field to the space between the coil and the workpiece. Pressure is then exerted on the surface equivalent to the field energy density. At the same time there will be some leakage of the field through the conductor (determined by its resistivity) and considerable heating. These losses are reduced to a practical minimum by limiting the duration of the magnetic pulse and need not exceed about 10% to 20% of the total energy delivered to the coil, with a suitable design of coil

The current required to produce a field strength of 300.000 gauss is of the order of 300,000 amp per centimetre of coil length, supplied from a capacitor bank in a typical charging and control circuit as shown in Fig. 4. With single phase 230 volt input, peak current need only be of the order of 25-30 amp, and RMS average current 7·5 amp. Storage energy is related to the size and capacity of the capacitor bank, a typical value here being 4500 ft lb. Thus this amount of energy input is available per pulse, maximum time to charge being about 2 sec with automatic discharging through the coil when the capacitor energy level reaches a pre-set figure. Energy conversion, expressed as an overall efficiency figure, is likely to lie between 10% and 50% depending on the set-up and the nature of the forming work done.

In fact, the overall efficiency figure is of relatively little significance provided the required working pressure is realised. It is more useful, therefore, to know the maximum pressure capacity of a particular machine which can most conveniently be derived in the form of an empirical or semi-empirical formula. A typical formula for a Magneform machine employing coils of optimum design supplied from a 4500 ft lb capacitor bank is

$$\text{Maximum pressure (psi)} = \frac{400{,}000}{\text{workpiece area (sq in.)}}$$

An important point to be considered in the design of the coils is that they will be subject to a reactive force equal in magnitude to the working force they are producing; also that this force is generated as an impulse of microseconds duration. Thus the coils must be of high mechanical strength and resistant to impact loads, if they are to have a reasonably long life. Where the coil is fully supported the limiting factor becomes the compressive strength of the coil material. However, the nature of the mechanical loading (microsecond impulses) does make it possible to use a high mass rather than a high strength coil to utilise inertia rather than physical strength to accommodate the reactive forces, in which case it is possible to extend the maximum field strength considerably, at the expense of coil life (i.e. the coil must be regarded as expendable). In certain circumstances it may also be possible to utilise 'free force' coils, the design of which results in a very low reactive force being exerted on the conductors.

The advantages offered by magnetic forming as a production tool are numerous. Compared with mechanical forming it has virtually no restriction as regards point of application and opens up possibilities in forming or production work not practical with conventional methods. The same machine can also be used for 'inside', 'outside' and 'flat' working simply by a change of coils

The fact that magnetic forming in a non-contact method means that the workpiece surface to which the forming pressure is applied cannot be scratched or marked as is often the case with mechanical forming. It is also effective where the conductive material is covered with an insulating coating, the lines of magnetic flux not being materially disturbed by the presence of an insulator. It does, however, come up against limitations in forming metals which may be poor conductors, which embraces the most common forming metal of all—steel. In such cases it may be necessary to apply a conductive 'driver' to the basic metal component, such as a sleeve or sheath, or even plating, in copper.

The most extensive use of magnetic forming at its present state of development, therefore, is for metal forming in light and medium gauges of such metals as aluminium, brass, copper and molybdenum (all good conductors), particularly in the swaging, forming, shaping, etc., of tubes and tubular products; and for coining, forming, shearing or blanking in these metals. It has also been used with steel sheet and tubes, but to a rather more limited extent. Basically it is adaptable to any conductor, but where the metal concerned has an electrical conductivity less than about 10% that of copper it is usually best formed either by first plating the work with copper or by using a driver of light gauge soft aluminium sheet in contact with the workpiece on the side distant from the forming coil.

Table I.—ELECTRICAL CONDUCTIVITY OF TYPICAL METALS

Metal or alloy	Conductivity (Copper = 100)	Conductivity compared with copper
Silver	106	—
Copper	100	—
Aluminium	62	62%
Magnesium	36	36%
Zinc	27	27%
Nickel	25	25%
Cadmium	16-20	16-20%
Iron	17	17%
Steel	11-17	11-17%
Tin	12	12%
Lead	7	7%
Nickel-Steel	5-6	5-6%
German Silver	5	5%
Manganese Steel	2-3	2-3%

Hydrostatic Moulding

A 24 in. press being made by Foster, Yates and Thom Limited of Blackburn, for the United Kingdom Atomic Energy Authority has been specially designed to increase the density of high explosive powders, at pressures up to 20,000 psi, within a temperature range of 20 to 100° C.

Powder, contained in a rubber bag, the mouth of which is sealed with a plug, is made denser by fluid pressure acting on the external surface of the bag. The plug is arranged to facilitate removal of air from the bag before and during the pressing cycle. Moulding shapes can be varied by formers within the bag.

The vessel has a 24 in. internal diameter and approximately 24 in. internal depth. It is of compound construction, made of 2½% Ni-Cr-Mo steel, and weighs 9 ton. The upward force on the removable lid, due to internal pressure, is approximately 4,000 ton; the lid is retained by eight, symmetrical, hydraulically operated, clamp jaws. Peak stresses in the vessel have been predicted by photo-elastic analysis.

The framework on which the vessel, jaws and clamp cylinders are mounted is 12 ft dia. Means are provided for conveying and loading the powder. The plant is hydraulically operated and the electrical control system is fully interlocked, and in places duplicated, for correct sequence.

Production of Components with Extruded Necks—II

The extruded neck for screw fastenings has to provide sufficient depth of metal for the thread and enough length to develop the full strength of the screw. Complete data are presented for producing necks to suit the principal screw thread forms in a range of sizes

By W. RICHARDS, A.M.I.Prod.E.

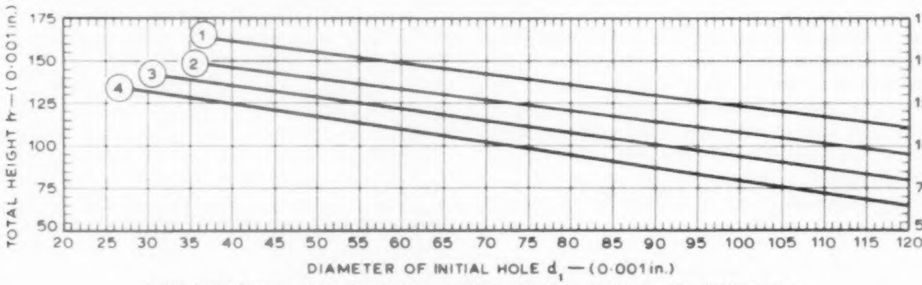
From the results obtained in producing the components, as given in the tables, the values of the total height h are plotted against the values of the diameter d_1 of the initial hole, giving Charts I and II. The charts show the total height obtained for a given initial hole diameter, or the initial hole diameter required to ensure any total height of a component, when all factors lie within the range of feasibility.

Referring to the charts it will be noted that the resulting graph lines are cut short at positions where the value of the initial hole diameter is equal to 20% of the diameter of the plunging punch—when for reasons given earlier the component involved is not recommended as suitable for tapping purposes. On the other hand, when the initial hole and plunging punch diameters are equal, there will be no extrusion. Referring especially to chart I for the 4 to 8 BA groups, the graph lines are cut short at the right-hand side. The material thickness used in the production of these groups is 0·031 in. and the graph lines are cut where the total height $h = 0·050$ in. thus the extruded neck would then have a length of $0·050 - 0·031 = 0·019$ in. only. This component is not suitable for tapping but may fit in with other requirements.

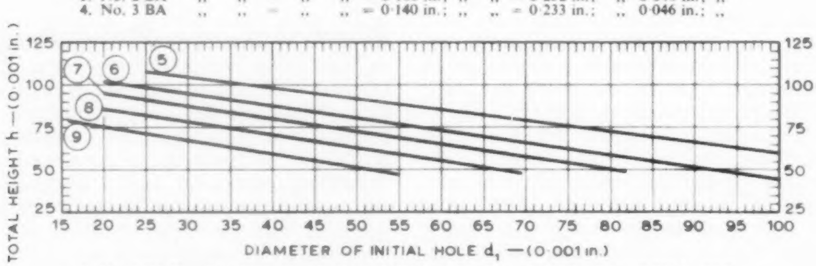
From Fig. 2 it is obvious that due to the limitations in the height h obtainable by the extrusion process, consideration must be given to the minimum threaded length of the component compatible with its strength and that of the screw to be used with it. Also, the thickness of the extruded neck would appear to compare unfavourably with that of the standard nut having the same thread.

Thus, if the material thickness falls below a certain minimum there will be a tendency for the neck to burst under the full load the corresponding screw would or could carry. It should be stated the resistance to bursting of the standard nut is far greater than is required for mere strength reasons.

Chart I.—RELATIVE VALUES OF h; d_1; d; D and T



1. No. 0 BA Tapping size = Punch dia = 0·204 in.; Die dia = 0·299 in.; Mat. 0·046 in. M.S.
2. No. 1 BA „ „ = „ „ = 0·184 in.; „ „ = 0·275 in.; „ 0·046 in.; „
3. No. 2 BA „ „ = „ „ = 0·160 in.; „ „ = 0·252 in.; „ 0·046 in.; „
4. No. 3 BA „ „ = „ „ = 0·140 in.; „ „ = 0·233 in.; „ 0·046 in.; „



5. No. 4 BA Tapping size = Punch dia = 0·121 in.; Die dia = 0·183 in.; Mat. 0·031 in. M.S.
6. No. 5 BA „ „ = „ „ = 0·109 in.; „ „ = 0·171 in.; „ 0·031 in.; „
7. No. 6 BA „ „ = „ „ = 0·097 in.; „ „ = 0·158 in.; „ 0·031 in.; „
8. No. 7 BA „ „ = „ „ = 0·087 in.; „ „ = 0·149 in.; „ 0·031 in.; „
9. No. 8 BA „ „ = „ „ = 0·074 in.; „ „ = 0·136 in.; „ 0·031 in.; „

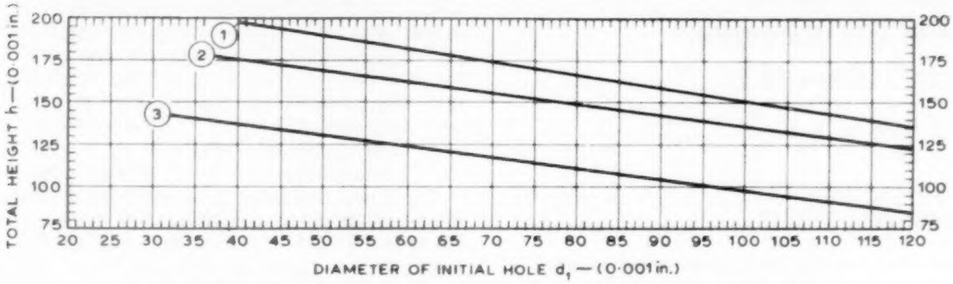
The minimum length of thread required is that length when the shearing strength of the threads is equal to the tensile strength of the screw, root diameter being considered.

Let, d = Root diameter of the screw
l = Required length of the threaded portion
S_t = Tensile strength of screw material
S_s = Shearing strength of screw material

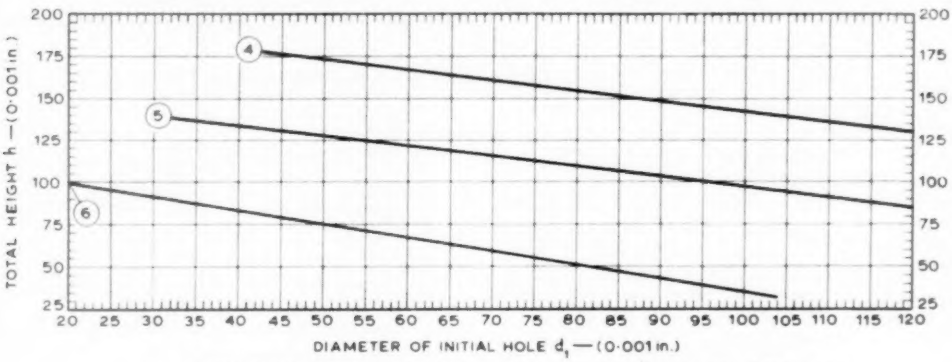
Tensile strength of screw = Root area $\times S_t$

$$= \tfrac{1}{4}\pi d^2 S_t \quad \ldots\ldots\ldots \text{(a)}$$

Chart II.—RELATIVE VALUES OF h; d_1; d; D and T



1. $\frac{1}{4}$ in. BSF Tapping Size = Punch dia = 0·219 in.; Die dia = 0·341 in.; Mat. 0·061 in. M.S.
2. $\frac{7}{32}$ in. BSF „ „ = „ „ = 0·185 in.; „ „ = 0·307 in.; „ 0·061 in. „
3. $\frac{3}{16}$ in. BSF „ „ = „ „ = 0·158 in.; „ „ = 0·250 in.; „ 0·046 in. „



4. $\frac{1}{4}$ in. Whit. Std. Tapping Size = Punch dia = 0·209 in. Die dia = 0·331 in.; Mat. 0·061 in. M.S.
5. $\frac{3}{16}$ in. „ „ „ „ = „ „ = 0·153 in. „ „ = 0·245 in.; „ 0·046 in. „
6. $\frac{1}{8}$ in. „ „ „ „ = „ „ = 0·104 in. „ „ = 0·166 in.; „ 0·031 in. „

Shearing strength of screw thread = area sheared $\times S_s$

$$= \pi \,.\, d \,.\, l \,.\, S_s \quad \ldots\ldots \text{(b)}$$

For equal strength, values (a) and (b) must be equal. Solving for l we have, $\pi\, d \,.\, l \,.\, S = \frac{1}{4}\pi \,.\, d^2 \,.\, S_t$

$$l = (\pi \,.\, d^2/4 \,.\, \pi \,.\, d) \times (S_t/S_s)$$

For steel, the average value of $S_t/S_s = 1{\cdot}4$

Thus, $l = \frac{1}{4}\, d \times 1{\cdot}4 = 0{\cdot}35\, d$ . . . . (c)

Formula (c) is applicable to any V-thread screw and nut pair, assuming a full thread and gauge fit between screw and nut.

Referring to Fig. 2, it is seen that owing to the curved opening at the flange end, the full height h of the component is not available for threading, and thus the minimum value of h must be greater than l as determined by formula (c) above. By experiment the writer concludes that a minimum value for the total height h of the extruded component required to compensate for the loss of threaded length due to the curved entrance and to provide a safety margin is conveniently expressed by the formula, $h = 0{\cdot}5\, d_o$ . . . .(*A*)

Thus the minimum total height of the extruded component should be equal to one half the full diameter of the screw. *To be concluded.*

New Stainless Steel

A new ferritic stainless steel containing 17% chromium and 1% molybdenum has been developed by Samuel Fox and Company, Limited, a subsidiary of The United Steel Companies Limited.

Known as Silver Fox 17 Mo, the addition of 1% molybdenum to a straight 17% chromium stainless steel has been found to give a marked increase in corrosion resistance without in any way adversely affecting the physical properties. Of all the many qualities of stainless steel produced, the 17% chromium quality represents the largest tonnage. It has been recognized for some time, however, that there was a need to enlarge the scope for using this relatively cheap stainless steel by improving its properties without adding appreciable quantities of expensive alloys. This objective has now been achieved with Silver Fox 17 Mo.

Comparative laboratory tests have been carried out at Samuel Fox with *Silver Fox* 17 Mo, *Silver Fox* 17 (straight chromium) and *Silver Fox* 302 (18/8 type). Samples of these steels were coated with mud, plus small amounts of sodium chloride with traces of dilute sulphuric acid and sulphur dioxide, and kept in a damp atmosphere for four days. The straight 17% chromium samples showed severe pitting, while Silver Fox 17 Mo was only slightly affected. This test is of particular relevance for applications such as motor car hub caps and trim below the waist-line.

Similarly good results were obtained in atmospheric corrosion tests, and tests with a variety of acids. The pressing and forming properties of the new steel are virtually indentical with Silver Fox 17.

Vertical Scale Thermometers

A mercury-in-steel actuated thermometer (model 605), with a vertical scale in place of the normal dial, has been produced by the British Rototherm Company Limited, Merton Abbey, London, SW19. The scale of the thermometer is 7½ in. long and under 2 in. wide, allowing as many instruments as required to be placed side by side in a small space. A bank of six thermometers measures 9¾ in. deep by 11½ in. wide overall.

Research and Power Reactors in Canada–III

—a review of progress

By J. R. FINNIECOME, M.Eng., M.I.C.E., M.I.Mech.E., F.Inst.F., Consulting Engineer

10. Estimated Generating Cost of CANDU Station

The generating cost is the sum of the fixed, the fuel and the operating charges and these are indicated below for one and two reactors with a net rating of 203 and 406 MW(E) respectively.

	Charges	One reactor mill/kW net	Two reactors mill/kW net
(a)	Fixed...	3·9 to 4·9	3·3 to 4·4
(b)	Fuel	1·1 1·1	1·1 1·1
(c)	Operating	1·0 1·0	0·7 0·7
(d)	Total (a)+(b)+(c) ...	6·0 to 7·0	5·1 to 6·2
(e)	Total with fuel at 0·88 mill/kW hr net ...	5·78 to 6·78	4·88 to 5·98

The total estimated generation costs, based on (d), expressed in pence per kWhr sent out for one and two reactors are (0·5161 to 0·6021) and (0·4387 to 0·5333) respectively. These values are based on £1 = 2·79 dollars, therefore one dollar equal to 86·02 pence and 1 mill = 0·1 cent = 0·08602 pence.

It is significant that Canada has one of the lowest rates per kWhr sent out in the world. The revenue from

Table III.—SUMMARY OF ESSENTIAL DATA OF CANADA'S NUCLEAR POWER REACTORS (NPD-2 AND CANDU).

1	2	3	4
1	Designation	NPD-2	CANDU
2	Owner	Atomic Energy of Canada Ltd.	Atomic Energy of Canada Ltd. Hydro-Electric Power Commission of Ontario, Toronto
3	Location	Rolphton, Ontario	Douglas Point on Lake Huron
4	Designers and manufacturers	Canadian General Electric Co. Ltd. (Reactor) AEI, England (Turbogenerator)	Canadian General Electric Co. Ltd. (Reactor AEI, England) (Turbogenerator)
5	Year of commissioning ...	1961	1965
6	Type of reactor	natural uranium heavy water moderated and cooled	natural uranium heavy water moderated and cooled
7	General		
	(a) Number of reactors ...	1	1
	(b) Number of heat exchangers	1	8
	(c) Number of main turbogenerators ...	1	1
8	Ratings		
	(a) Thermal rating of reactor	82·5 MW	698 MW
	(b) Net electrical output from the station ...	17 MW	203 MW
	(c) Maximum rating of turbogenerator... ...	22 MW	220 MW
9	Overall thermal efficiency of station		29·1%
10	Fuel		
	(a) Type	sintered natural uranium oxide pellets	sintered natural uranium oxide pellets
	(b) Quantity	15·8 tonne	47·1 tonne
	(c) Quantity per MW (thermal)	0·1915 tonne	0·05973 tonne
	(d) Quantity per MW (net)	0·9683 tonne	0·2320 tonne
	(e) Average burn up (MWd/tonne)	4300	9750
11	Fuel elements		
	(a) Diameter of pellets (in.)	0·937	0·937
	(b) Length of pellets (in.)	0·832	0·832
	(c) Diameter of elements (in.)	1·000	1·000
	(d) Thickness of cladding (in.)	0·025	0·015 and 0·030
	(e) Material of cladding	zircaloy-2	zircaloy-4
	(f) Type of subassembly	cylindrical	cylindrical
	(g) Number of pellets in each element	22	22
	(h) Number of fuel elements in each subassembly	7	7
	(i) Number of subassemblies for each coolant pressure tube	9	12
	(j) Total number of coolant pressure tubes	132	306
	(k) Total number of pellets	18395	56549
	(l) Outside diameter of each subassembly (in.)	3·2	3·2
	(m) Length of subassembly (in.)	19·5	19·5
	(n) Maximum sheath temperature (°F) ...	547	575
	(o) Maximum internal temperature (°F) ...	4000	4000
	(p) Maximum heat flux (Btu/hr/sq ft)	225,000	330,000
12	Coolant pressure tube		
	(a) Number	132	306
	(b) Inside diameter (in.)	3·25	3·25
	(c) Thickness of wall (in.)	0·163	0·157
	(d) Length	13 ft 3 in.	17 ft 7 in.
	(e) Material	zircaloy-2	zircaloy-4
	(f) Material of end fitting	stainless steel	stainless steel
	(g) Overall length of assembly	19 ft 2 in.	30 ft 3 in.
13	Moderator	heavy water	heavy water
14	Core		
	(a) Number of cells ...	132	306
	(b) Lattice type	square	
	(c) Lattice pitch	10¼ in.	9 in.
	(d) Diameter of the core	11 ft 10 in.	
15	Reflector		
	(a) Form (primary and secondary)	liquid annulus	
	(b) Material		
	Primary	heavy water	
	Secondary	light water	
	(c) Quantity		
	Primary	15·66 tonne	
	Secondary	45·30 tonne	
	(d) Radial thickness		
	Primary at centre ...	21·6 in.	
	at end ...	5·6 in.	
	Secondary at centre	11·8 in.	
16	Calandria		
	(a) Shell		
	Type	horizontal and cylindrical	horizontal and cylindrical
	Material	ALCAN 57S aluminium alloy	austenitic stainless steel
	Internal diameter ...	17 ft	19 ft 8 in.
	Internal length ...	15 ft	16 ft 5 in.
	Inner wall thickness:	¼ in.	
	Outer wall thickness:		
	sides	¼ in.	
	ends	1½ in.	
	(b) Tubes		
	Material		zircaloy-2
	Internal diameter ...	4 in.	4·2 in.
	Wall thickness ...	0·054 in.	0·05 in.
17	Primary coolant		
	(a) Type of coolant ...	heavy water	heavy water
	(b) Total quantity (lb) ...	28,060	94,000
	(c) Total flow (lb/hr) ...	5,140,000	24,100,000
	(d) Inlet temperature (°F)	485	480
	(e) Outlet temperature (°F)	530	560
	(f) Rise in temperature (°F)	45	80
	(g) Inlet pressure (psig)...	1113	1473
	(h) Outlet pressure (psig)	1021	1310
	(i) Drop in pressure (psi)	92	163
18	Primary coolant pumps		
	(a) Type	shaft sealed centrifugal	shaft sealed centrifugal
	(b) Total number	3 at 50%	10
	(c) Number normally in operation	2	8
	(d) Arrangement of pumps		2 groups of 5
	(e) Capacity of each pump (g(US)pm) ...	5,000	7,000
	(f) Diameter of pump branch	10	
	(g) Rating of electric motor (HP)	800 (each)	
	(h) Material	11 to 13% chromium steel	
19	Primary coolant piping		
	(a) Material	ASTM Type A 106 Schedule	
	(b) Diameter of main pipe	16 in.	
	(c) Diameter of feeder pipe	1½ in.	

domestic consumers averaged 1·62 cents (1·3935 pence) per kWhr in 1957 as compared with 2·56 cents (2·2021 pence) in the United States. The values for commercial and industrial sales average 0·8 cent (0·6882 pence) per unit in Canada and 1·3 cents (1·1183 pence) in the United States. In 1957 the average bills for domestic and farms was \$64·9 (£23·1) whilst the provincial ones range from \$87·44 (£31·34) for British Columbia to \$51·51 (£18·46). The total units generated in 1957 in Canada were 91,020,880,000 of which 91·58% was produced by water power and 8·42% thermally. A comparison of the revenues from the sale of electricity

Table IV.—SUMMARY OF ESSENTIAL DATA OF CANADA'S NUCLEAR POWER REACTORS (NPD-2 AND CANDU)

1	2	3	4
1	Designation	NPD-2	CANDU
2	Main heat exchanger		
	(a) Number	1	8
	(b) Type	vertical U-shell and tubes with steam drum	vertical U-shell and tubes with steam drum
	(c) Total surface boiling area (sq ft)	6,200	74,500
	preheating area (sq ft)	—	11,050
	(d) Material of tubes ...	Inconel	Monel
	(e) Outside diameter ...		½ in.
	(f) Total evaporation (lb/hr)	300,000	2,562,000
	(g) Steam pressure at outlet (psig)		583·7
	(h) Wetness of steam at outlet (%)...		0·25
	(i) Feed water inlet temperature (°F) ...	300	340
	(j) Heavy water velocity (ft/sec)	15·4 ft	
	(k) Heavy water pressure drop (psi)	21·1	
3	Turbogenerator set		
	(a) Manufacturer	AEI	AEI
	(b) Maximum rating (MW)	22	220
	(c) Speed (rpm)	3600	1800
	(d) Heat rate (Btu/kWhr)	12550	10230
	(e) Thermal efficiency (%)	27·19	33·34
	(f) Type of turbine ...	single cylinder (15 stages)	tandem cylinder
	(g) Number of water separators	two	two (in parallel)
	(h) Number of reheaters	none	two (in parallel)
	(i) Pressure at turbine stop valve (psig) ...	400	565
	(j) Temperature at turbine stop valve (°F) ...	450	482
	(k) Pressure at L.P. inlet (psia)...		67·9
	(l) Temperature at L.P. inlet (°F)		430
	(m) Vacuum at turbine exhaust (in Hg) ... (30 in. Hg bar)	28·5	29·0
	(n) Final feed temperature (°F)	300	340
	(o) Number of feed heating stages	3	6
	(p) Number of L.P. heaters	1	3
	(q) Number of direct-contact deaerators ...	nil	1
	(r) Number of H.P. heaters	2	2
4	Main turbogenerator		
	(a) Maximum rating (kVA)	25,882	244,444
	(b) Power factor	0·85	0·9
	(c) Voltage at terminals (kV)	13·8	18·0
	(d) Frequency (cycles/sec)	60	60
	(e) Number of phases ...	3	3
	(f) Speed (rpm)	3600	1800
5	Condenser (surface)		
	(a) Type	two pass central flow	single pass central flow
	(b) Total surface (sq ft) ...	22,000	158,000
	(c) Surface per kW (MCR) in sq ft	1·0	0·7183
6	Extraction pump		
	(a) Number	one	
	(b) Type	vertical two stage	
	(c) Capacity (gpm) ...	550	
	(d) Head (ft)	140	
7	Circulating water pump		
	(a) Number	two at 70%	
	(b) Type	vertical	
	(c) Capacity (gpm) ...	12,600	
	(d) Head (ft)	150	
8	Dump condenser		
	(a) Steam capacity (lb/hr)	200,000	
	(b) Surface (sq ft)	5,000	
	(c) Operating pressure ...	atmospheric	

in Canada and Great Britain is indicated in Table V.

Table V.—COMPARISON OF REVENUES IN CANADA AND GREAT BRITAIN.

	Revenue	Canada	Great Britain
(a)	Domestic (pence/kWhr sold)	1·3935	1·581
(b)	Commercial (pence/kWhr sold)		2·016
(c)	Industrial (pence/kWhr sold)		1·265
(d)	Commercial and industrial (pence/kWhr sold	0·6882	

These values reveal that the Canadian price per unit sold is much lower than that in Great Britain.

11. Comment on Canada's Reactors

There is no doubt that Canada leads the world in exploring with exceptional thoroughness the natural uranium, heavy water research and power reactors, for no country can claim to have had such unique design and operating experience with this type. Her nuclear research establishment at Chalk River must be regarded as the first of its kind in the world. This prototype proved to be of significant importance to nuclear physicists, particularly those interested in reactor design. At Chalk River there are four natural uranium heavy water research reactors in operation, the thermal ratings varying from 10 W (ZEEP) to 200 MW (NRU), as indicated in Table I, items 1 to 3 and 7. In addition there is the research reactor OCDRE (Table I, item 8) at the new establishment at Whiteshell between the north shore of Sylvia Lake and the Pinawa Channel, about 50 miles north-east of Winnipeg. It is the first Canadian reactor to be cooled by an organic liquid. Then there are the three power reactors NPD-2, CANDU and finally OCDR for nuclear stations (Table I items 9 to 11 inclusive). The net electrical output of these is 20 MW, 203 MW and 153·6 MW respectively.

It is of special significance that Canada's natural uranium, heavy water power reactor concept fits exceptionally well into her nuclear economy for she has vast resources of uranium, but at present does not have the plant for producing enriched uranium. Canada's ore contains 0·715% U235. Her progress in this type of reactor has received world wide recognition. The United States has agreed to co-operate with Canada in an extensive programme of development on heavy water reactors. There is to be a mutual exchange of personnel and information and the United States has arranged to contribute about \$5 million (£1·79 million) towards such research, conducted in Canada. In spite of recent criticism, the Atomic Energy of Canada Limited is convinced that the natural uranium, heavy water reactor is an economic proposition. A burn-up of 10,000 MWD per tonne U from zircaloy-clad, natural uranium fuel will be achieved without processing. With this high-burn-up, the spent fuel may be treated as waste for it is rather doubtful whether expensive reprocessing of the fuel would be worth while. It must be emphasized that in other types of natural uranium reactors the burn-up is about 3,000 to 4,000 MWD per tonne U. The essential merit of the heavy water reactor is that power production costs are lower. Unfortunately, Canada has to import the heavy water, generally from the United States, for at the moment she has not the plant to produce it. Estimates reveal that the nuclear power programme in Canada will require in 1980 about 4000 tonne of heavy water and 2500 tonne of natural uranium with an annual uranium make up of 700 tonne. Canada's uranium oxide production in 1957, 1958 and 1959 was 6,635, 14,118 and 15,909 tonne respectively.

Table VI.—ESSENTIAL DESIGN DATA OF ORGANIC LIQUID COOLED HEAVY WATER MODERATED NATURAL URANIUM REACTOR (OCDR)

1	Net electrical power output	153·6 MW
2	Owner	Atomic Energy of Canada Ltd.
3	Designers and manufacturers	Canadian General Electric, Co
4	Fuel	sintered natural uranium oxide (UO_2) sintered AL powder
5	Cladding	Alloy M255
6	Core diameter	15 ft
	height	14 ft
7	Number of pressure tubes	312
8	Active zone fuel capacity	39 ton UO_2
9	Material of pressure tubes	ALCAN 57S AL alloy
10	Maximum sheath surface temperature ...	870°F
11	Maximum heat transfer	435,000 Btu/hr/sq ft (138 W/cm²)
12	Coolant	Santowax OM
13	Coolant velocity in pressure tube ...	31 ft/sec
14	Inlet temperature of coolant	575°F
15	Outlet temperature of coolant	800°F
16	Temperature rise of coolant	225°F
17	Pressure of coolant at inlet of pressure tubes	146 psig
18	Pressure of coolant at outlet of pressure tubes	30 psig
19	Pressure drop of coolant in pressure tubes	116 psi
20	Coolant damage rate	52·2 lb/hr

Table VII.—SOME PROPERTIES OF POLYPHENYL HYDRO-CARBONS (ORGANIC COOLANTS)

1	2	3	4	5	6	7	8	9	10	11
		Composition				Melting point pure	Melting point w.30% HB	Vapour pressure at 800°F	Viscocity at 800°F centipoise	Cost cents per lb
		Diphenyl	O-terphenyl	M-terphenyl	P-terphenyl					
		%	%	%	%	F	F	psia		
1	Diphenyl	100	—	—	—	160	136	232	0·15	21
2	Santowax OM	—	65·2	32·3	2·5	125	65	57	0·18	51
3	Santowax OM (17-83)	—	17·0	83·0	—	180	130	32		39
4	Santowax OMP	—	12·5	62·5	25·0	300	260	32		21
5	Santowax R	0·3	11·7	60·0	28·0	312	279	37	0·22	21

Its value varies from $10 to $10·3 per pound (£3·584 to £3·692).

It is of interest to refer to the remarks of Dr. Balke, Minister of Atomic Affairs for West Germany, based on a visit to Atomic Energy of Canada Limited. He emphasized that the CANDU reactor was the only design in the world which is assessed on a reasonable commercial basis. He stated that West Germany was not interested in enriched uranium power reactors, but preferred a reactor fuelled by natural uranium and moderated by heavy water, as it can produce power more economically.

12. Organic Liquid Cooled Heavy Water Moderated Natural Uranium Reactor (OCDRE and OCDR)

Early in 1958 the Canadian General Electric Company at Peterborough, Ontario, indicated that organic liquid coolant was reasonably attractive for the natural uranium, heavy water moderated reactor. On their own initiative they carried out a fairly detailed design study of such a reactor to produce a net electrical power output of 153·6 MW. The use of the organic liquid cooled reactor reduces the heavy water inventory from $55 (£19·72) per kW for the CANDU to $35 (£12·54) per kW. This represents a reduction in the heavy water charges of 34·37%. In addition a greatly improved steam cycle is obtained.

The cost of the organic liquid coolant, such as Santawax OM, to be used in the reactors OCDRE and OCDR, is about 50 cents (3s. 7d.) per lb, whilst that of heavy water amounts to $28 (£10) per lb. Therefore the price ratio is 1 to 56, which is remarkable. The cost of a heavy water moderator is comparable to that of a graphite core when taking into account the machining and assembly of the blocks.

The experimental investigations on the organic liquid cooled, natural uranium heavy water moderated reactor is being conducted on the prototype OCDRE where the last letter E denotes experimental. It has a thermal rating of 31·5 MW and is designed by the Canadian General Electric Company under the sponsorship of AECL.

The essential design data of OCDR for a nuclear power station with a net electrical output of 153·6 MW is presented in Table VI. In the core are 312 internally insulated vertical coolant tubes, surrounded by the heavy water moderator. The organic liquid coolant flows up the tube past the natural uranium oxide (UO_2) and collects in a header just above the core and then goes on to the steam superheater and boiler. The reactor is controlled by adjusting the level of the heavy water moderator as in the NPD-2 and CANDU power reactors. Rapid shut-down is achieved by running off the heavy water through the dump floor. Immediately above the core is a 30 ft deep shield pool of organic liquid. The fuel consists of two 7 ft long assemblies of sheathed sintered natural uranium oxide (UO_2). Recent investigations reveal that a 19 element design similar to that being developed for CANDU, is more promising. The core has a diameter of 15 ft and a height of 14 ft and the organic liquid is Santawax OM, which is a polyphenyl hydrocarbon, consisting of 65·2% O-terphenyl, 32·3% M-terphenyl and 2·5% P-terphenyl. Other properties are indicated in Table VII, item 2, columns 7 to 10 inclusive. The last column 11 gives the cost in cents per pound.

To be continued.

Improved Trojan Tractor

The 2 cu yd capacity Model 204 Trojan Tractor made by The Yale & Towne Manufacturing Company, Wednesfield, Staffs., has been given a "new look". New exterior cowling is now being fitted to this four-wheel drive rubber-tyred tractor shovel, streamlining the appearance of the machine. From a functional standpoint the new cowling has improved operator visibility without impairing his safety. The front and rear lights have been recessed in the cowling to give the tractor a much neater appearance. A further change is the introduction of the Leyland 0·370 six cylinder diesel engine one of the Power Plus series which develops 109 gross hp and 272 ft-lb torque at 2200 rpm. Tests show a significant increase in output and an improved fuel consumption in respect to tons handled per gallon.

New Warehouser truck

The new Warehouser Extend-a-load truck from the same maker gives a low overall height with the mast fully elevated by utilizing a horizontal pantograph system, giving an increased depth of reach when loading and unloading lorries. Designed with high lifting and horizontal speeds, a 24 volt system reduces the voltage drop and decreases the current loading required to achieve this performance.

The name "Acheson" and the trade mark "dag" are known to industry all over the world. The manufacture of dispersions is our business. We are concerned with the nature of surfaces and with the art and science (for there is an element of both) of dispersing solids in liquids. We are concerned with lubrication yet by no means exclusively for electrically conducting coatings also occupy much of our time. Many technical people, those who know our products as well as those who ought to but do not, are hazy about the meaning and purpose of solid lubricants and colloidal dispersions. We realise these are familiar descriptions to us but possibly meaningless or at best vague to others. What, they ask us, are colloids? Why use dispersions? Where are they used? What do they offer? These are fair questions which we are often asked and enjoy answering. In this guide—and it can be no more than that— we attempt to answer them simply, briefly and, we hope, convincingly. We suggest you keep it by you for reference.

ACHESON
INFORMATION BULLETIN
Published by—Acheson Colloids Ltd., Plymouth.

Why solids ?

The uses of the solids we disperse are legion. Principally however they either keep two surfaces apart, or provide an electrically conducting coating on insulating materials. The former is, of course, the purpose of all lubrication, be it of mechanical plant or production processes. Sometimes however, where the surfaces do not slide over each other, the solid material acts only as a parting or release agent. In some processes both functions occur.

The commonest lubricant is mineral oil often containing various protective additives. Ideally, if it were possible to keep a film of sufficient thickness permanently between the moving surfaces, wear would not occur and friction would only be the force required to shear the oil film.

LIMITATIONS OF FLUID LUBRICANTS

Conventional fluid lubrication may, however, break down or be impossible for three main reasons—bearing surface irregularities, high temperatures, and high loads.

Even the finest finish on a bearing surface is in fact microscopically rough and initially, if unlubricated, all the load is carried by the high spots. The actual bearing area provided by these spots is a very small proportion of the apparent surface and the initial contact pressure is thus so high that the metal deforms until the area is sufficient to carry the load. This deformation commonly produces welding between the areas in contact and, when the surfaces slide relative to each other, the local welds are torn apart resulting in wear.

Even the smoothest bearing surfaces are microscopically rough.

Thus an oil film gives protection provided it is thick enough to prevent the high spots touching. In practice this is not always the case, for example:—

During running-in, relatively large surface irregularities usually pierce the oil film:

Where there is accidental loss of oil pressure at the bearing:

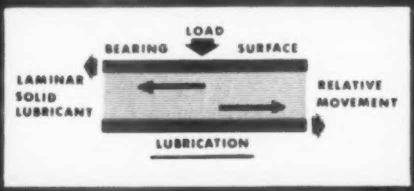
As the temperature is raised, the viscosity of the oil is reduced and the additives eventually lose their effectiveness:

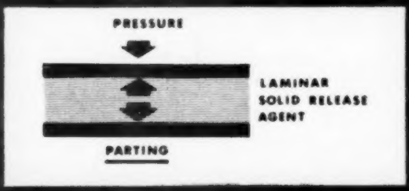
Where high transient loadings occur.

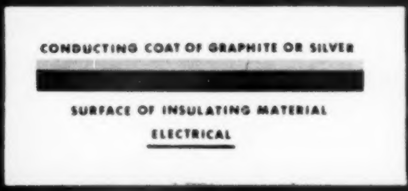
Solid lubricants can be of great benefit in these circumstances because they bond firmly to the moving surfaces, have a low shear strength, and thus prevent metal to metal contact and wear.

HIGH TEMPERATURES AND PRESSURES

It is of great industrial significance that the properties of solid lubricants are maintained at temperatures considerably above those at which conventional lubricants carbonize. Their adhesion to metal surfaces is such that effective lubrication is maintained under the extremes of temperature or pressure occurring in such metal forming processes as extrusion and wire drawing. These materials are also invaluable as combined lubricants and release agents in such processes as forging, rolling and die casting where their property of providing some heat insulation is an added benefit. Their use in these operations not only gives longer die life but improves the surface finish of the products.





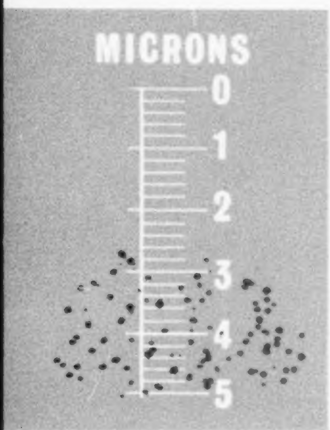


WHAT SOLIDS?

The two outstandingly successful solid lubricants are graphite and molybdenum disulphide. We are often asked which is the better. It is, however, as sensible to say that a camel is a better beast of burden than a horse as it is to say that molybdenum disulphide is "better" than graphite or vice versa. It all depends on the conditions in which they operate. As manufacturers of dispersions of both, Acheson can provide a neutral, unbiased assessment of the relative merits of either in a given situation.

For electrical applications, graphite or silver are mainly used according to the conductance and other properties required. Other dispersed solids in the Acheson range include PTFE, vermiculite, glass, wax, mica, lead, talc and gold, providing a comprehensive group for most industrial purposes, but our range is constantly growing to meet user needs.

Rotary wire brushing shows strength of solid lubricant to metal bond.



stability

Stated simply, Acheson colloidal dispersions are homogeneous suspensions of extremely small particles in fluids. They are very stable, that is resistant to aggregation and settlement of the particles. These and other properties offer striking advantages over the use of normal so called fine powders either alone or mixed in fluids.

high covering power gives economy

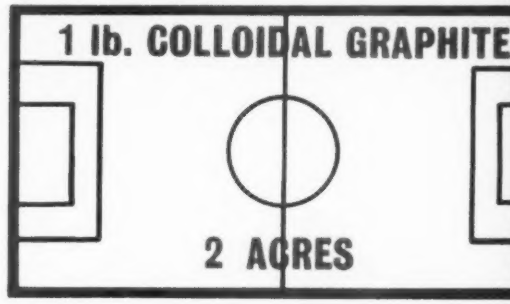
The fine particles give great economy. Acheson dispersions are so stable that only very thin films are needed for most applications. A typical dispersion would have particles mainly between 0·1 and 1 micron in size (1 micron is a forty millionth of an inch). In practical terms this means that a pound of, say, graphite would have a total particle surface area equal to that of a football pitch.

fineness suited to operating conditions

Acheson's produce a range of dispersions of varying particle sizes to enable them to recommend one exactly suited to the conditions in the user's works.

$\frac{1}{2}$ TEASPOON

1,000 MILLION PARTICLES



concentrates for efficiency and economy

Acheson products are supplied in very concentrated form and are commonly diluted by the user. It is thus possible to choose the correct diluent and dilution ratio for the job

versatility

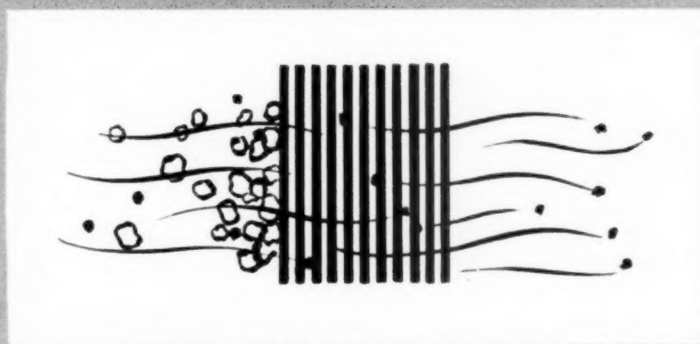
Acheson dispersions have hundreds of uses in industry. One may have to withstand very high temperatures; another will be applied during the assembly of plant and equipment; another incorporated in engine oil to maintain an enriched surface on bearings, cylinders, camshafts and other components; yet another will be used to pretreat dies or sprayed on them during forging, extrusion, wiredrawing and other metal forming operations, generally under high temperature conditions, whereas others provide electrically conducting coatings. Except where greases or pastes are more appropriate media, the best method of carrying solid particles to a surface is to disperse them in a suitable liquid—oil, water or volatile solvent.

aphite silver vermic
vermiculite
mica PTFE graphite
d disulphide

solid ?

FINE PARTICLES PASS FILTERS AND NARROW OILWAYS

Particles in colloidal suspensions are so fine they pass freely through filters and oilways. It is, for instance, possible for two hundred one micron particles in an Acheson dispersion to pass abreast through a ·0075 in. diameter hypodermic needle. When Acheson colloidal graphite or molybdenum disulphide is added in the recommended proportions to engine oil, every cubic centimetre (about half a teaspoonful) of oil will contain something like a thousand million particles. Even when the proportion is reduced until the oil appears clear to the naked eye, one million particles per c.c. will remain.



choice of carrier liquids

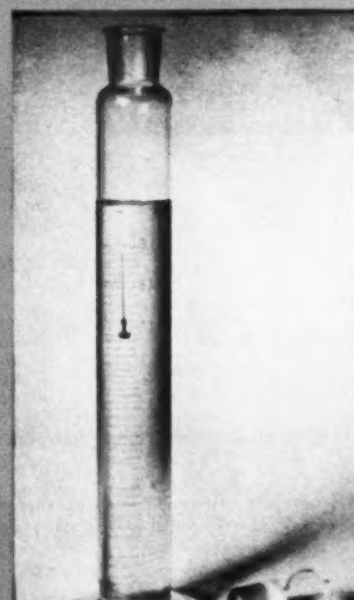
Acheson dispersions are available in an extensive range of carrier liquids. The choice for your purpose will depend on the conditions in which the dispersion is to be used. Temperature, type of surface, permissible materials—these and many other factors must affect the decision. This is where the Acheson team of field engineers, with their intimate knowledge of the products and your industrial processes, come into the picture.

dry coatings

The use of volatile carriers makes it possible to produce dry lubricating, parting or conducting coatings, applied by spraying, brushing or dipping, on any type of surface under a very wide range of conditions and resistant to most adverse circumstances.

COLLOIDAL SIZE PARTICLES GIVE GREAT COVERING POWER

A drop of concentrated Acheson dispersion of graphite in 100 c.c. of light oil. If the measuring cylinder is shaken the contents become fully opaque. A drop containing the same weight of material but consisting of the finest graphite powder merely mixed with a carrier liquid has no effect on the opacity of the contents. Similar failure occurs when poor quality dispersions of large particle size are used.



ite molybdenu

disulphide mica PT

gold glass

Preliminary Design of Gas Turbine Plant—V

Selecting the main dimensions of the compressor

By W. R. THOMSON, B.Sc.Tech.

7.10. Work in first stage

At tip: $u_o = u_m \times 1/0{\cdot}85$, hence u_o/V_a

$$\tan\alpha_1 = \sqrt{0{\cdot}36/M_a{}^2{}_{in} - 1}\ ;\ \frac{\tan\alpha_1 + \tan\alpha_2}{2u_o/V_a} = \text{reaction}$$

$= 0{\cdot}55$ hence $\tan\alpha_1 + \tan\alpha_2$ and then $\tan\alpha_2$. From Fig. 7 $\tan\alpha_o + \tan\alpha_1 = u_o/V_a$ hence $\tan\alpha_o$; $\tan\alpha_2 + \tan\alpha_3 = u_o/V_a$, hence $\tan\alpha_3$ which is constant for the blade.

Stage work $= u_o V_a (\tan\alpha_1 - \tan\alpha_2)/g J = k \Delta T_1$.

7.11. Optimum work in last stage

Mean: $(s/c)_m = 0{\cdot}7\, d_m/d_i$. Read $\tan\alpha_1$ from Fig. 11 for u_m/V_a and $(s/c)_m$. From Fig. 8, $\tan\alpha_1 = \tan\alpha_3$ with 50% reaction and $\tan\alpha_o = \tan\alpha_2 = u_m/V_a - \tan\alpha_1$.

Optimum work $= u_m V_a (\tan\alpha_1 - \tan\alpha_2)/gJ = k\Delta T_c$.

7.12. Number of stages

The total work absorbed by the compressor is $k\ \delta T/0{\cdot}86$ the latter number being called the "work factor". Divide $k\ \delta T/0{\cdot}86$ by $\frac{1}{2}(k\Delta T_1 + k\Delta T_c)$ expressing the result as $n\ (1 + x)$ where n is the *nearest* integer. The result will then lie between $n - 0{\cdot}5$ and $n + 0{\cdot}5$ so that x will lie between $-0{\cdot}5/n$ and $+0{\cdot}5/n$. If x is between $-0{\cdot}5/n$ and $+0{\cdot}1$ use n stages: if between $+0{\cdot}1$ and $+0{\cdot}5/n$ use $n + 1$ stages.

7.13. Actual work in last stage

Without changing $k\Delta T_1$ find the correct value of $k\Delta T_2$ (the last stage work) to balance out, i.e. $k\Delta T_2 = 2k\delta T/0{\cdot}86\, n - k\Delta T_1$ for x between $-0{\cdot}5/n$ and $+0{\cdot}1$ $= 2k\ \delta T/0{\cdot}86\ (n+1) - k\Delta T_1$ for x between $+0{\cdot}1$ and $+0{\cdot}5/n$.

Then $\tan\alpha_1 - \tan\alpha_2 = gJk\Delta T_2/u_m V_a$, and with 50% reaction $\tan\alpha_1 + \tan\alpha_2 = u_m/V_a$ hence $\tan\alpha_1$ ($= \tan\alpha_2$).

7.14. First stage reaction at mean diameter

This may now be checked to see that it is sufficiently close to 50%. If not considered near enough, the value of 55% at outer diameter could be modified and the calculations repeated.

Mean: $\tan\alpha_1, - \tan\alpha_2 = (\tan\alpha_1 - \tan\alpha_2)_o\, u_o/u_m$
$\tan\alpha_2 + \tan\alpha_3 = u_m/V_a$. Tan α_3 from sect. 7.10 hence $\tan\alpha^2$ and $\tan\alpha_1$. Reaction $= (\tan\alpha_1 + \tan\alpha_2)/(2u_m/V_a)$.

7.15. Air angles at root

Carry out all the rest of the design calculations for both stages, first and last.

Root: $\tan\alpha_1 - \tan\alpha_2 = (\tan\alpha_1 - \tan\alpha_2)_m\, u_m/u_i$ for last stage
$= (\tan\alpha_1 - \tan\alpha_2)_o\, u_o/u_i$ for first stage if reaction at mean diameter was not checked.

Tan $\alpha_2 + \tan\alpha_3 = u_i/V_a$ hence $\tan\alpha_2$ and $\tan\alpha_1$. Finally α_1 and α_2 also $\epsilon = \alpha_1 - \alpha_2$.

7.16. Blade angles at root

The blade camber θ is obtained from the equation $\theta = a\sqrt{\epsilon - b} - c$, and the incidence i from $i = d - e\theta$, where the values of a, b c, d, and e are obtained by interpolation from the following table based on the value of the fluid outlet angle, α_2, and $s/c = 0{\cdot}7$:

α_2	a	b	c	d	e
0	18	13·7	31	13·6	·37
10	20	9·3	49	12·6	·37
20	23	6·8	63	12·5	·40
30	24	4·0	78	12·7	·42

Then $\beta_1 = \alpha_1 - i$ and $\beta_2 = \beta_1 - \theta$ (see Fig. 10). Here a check on these angles may be made by finding the deviation $\delta = \alpha_2 - \beta_2$. Since the blading used is of medium stagger, the old rule $\delta = 0{\cdot}26\ \theta\ \sqrt{s/c}$ may be applied as a check.

7.17. Centrifugal stress for parallel blades

For non-tapered blades $f_c = 3{\cdot}32\rho\ (h/d_m)\ (u_m/100)^2$ ton/in². For light alloy blading $\rho = 0{\cdot}1$ lb/in.² (an average value) and $f_c = 0{\cdot}332\ (h/d_m)(u_m/100)^2$ ton/in.². For steel blading $\rho = 0{\cdot}283$ lb/in.² and $f_c = 0{\cdot}968\ (h/d_m)(u_m/100)^2$ ton/in.². These values require reducing on account of the thickness taper always employed.

7.18. Stress factors for tapered blades

Three types of taper are included and illustrated in Fig. 13.

7.18.1. Straight taper

$$\phi = 1 - \frac{1 - t_o/t_i}{3} \cdot \frac{2 + d_i/d_o}{1 + d_i/d_o}$$

Use $t_m/t_i = 0{\cdot}1/0{\cdot}13$ and $t_o/t_i = 0{\cdot}07/0{\cdot}13$.

7.18.2. Parabolic taper

Here each parabola has its vertex at the blade tip.

$$\phi = 1 - \frac{1 - t_o/t_i}{6} \cdot \frac{5 + 3d_i/d_o}{1 + d_i/d_o}$$

Use t_o/t_i as above.

7.18.3. Double straight taper

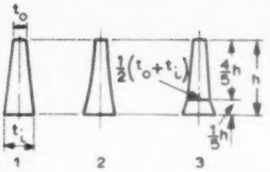
This is a convenient approximation to the parabolic taper. With mean thickness $\frac{1}{2}(t_o + t_i)$ at $\frac{1}{3}$ of the blade height from the root.

$$\phi = 1 - \frac{1 - t_o/t_i}{150} \cdot \frac{8(11 + 4d_i/d_o) + 4(7 + 8d_i/d_o) + (2 + 13d_o/d_i)}{1 + d_i/d_o}$$

Use t_o/t_i as above.

7.19. Centrifugal stress for tapered blades

$f_c = 0{\cdot}332\phi\ (h/d_m)(u_m/100)^2$ ton/in.² for light alloy
$= 0{\cdot}968\phi\ (h/d_m)(u_m/100)^2$ ton/in.² for steel.



(THICKNESS MUCH EXAGGERATED)

Fig. 13.—Tapered blades (compressors and turbines)

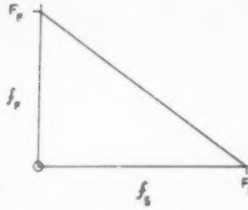


Fig. 14.—The Goodman diagram

7.20. Combined stresses

The total steady stress f_s is the sum of the centrifugal and gas bending stresses f_c and f_b. In the absence of other knowledge of the fatigue stress due to vibration, the blades are designed so that an additional alternating stress f_f, equal in magnitude to n times the bending stress, will just cause rupture when coupled with the steady stress. The Goodman diagram is shown in Fig. 14. Where the equation for the linear relationship between f_f and f_s is

$$f_f = F_f - \frac{F_f}{F_s} f_s$$

For light alloy $F_f = 11$ ton/in.^{2} and $F_s = 28$ ton/in.^{2}
For steel ($S80$) $F_f = 30$ ton/in.^{2} and $F_s = 58$ ton/in.^{2}.
These may be taken as typical values.

But $f_s = f_b + f_c$ and $f_f = nf_b$, hence the equation becomes $f_b = \dfrac{F_f(1 - f_c/F_s)}{n + F_f/F_s}$. Thus from knowledge of the centrifugal stress f_c the bending stress can be estimated. The quantity n is a factor of safety and would lie between 3 and 6, the latter value being applicable to long-life continuously operated plants.

7.21. Bending stress

An approximate simplified equation for f_b in terms of the bending moment and blade properties is

$$f_b = \frac{ab}{\{10(t/c)_i\}^2} \cdot \sigma \left(\frac{s}{c}\right)_m \cdot \left(\frac{h}{c_i}\right)^2 \cdot \frac{\Delta T}{10}$$

where σ = relative fluid density at entry to stage

$$= \frac{P}{14{\cdot}7} \cdot \frac{288}{T} = \frac{19{\cdot}6P}{T} \text{ for the first stage and}$$

$$= \frac{19{\cdot}6 P_{out}(1 - \Delta T/T_{out})^{(\gamma_x\gamma)/(\gamma-1)}}{T_{out} - \Delta T} \text{ for the last stage for}$$

which, so far, only P_{out}, T_{out}, and $k\Delta T$ are known. The mean k for the whole compressor is used.

Further, c_i = chord at root (the aim of the design)

$$(s/c)_m = 0{\cdot}7 \text{ and } (t/c)_i = 0{\cdot}13$$

$$a = 0{\cdot}157 + \frac{0{\cdot}186}{u_i/V_a - 0{\cdot}257}$$

$$b = 1{\cdot}2 - \theta/175 \text{ for } \theta < 35^\circ$$
$$= 1{\cdot}05 - (\theta/155)^2 \text{ for } \theta > 35^\circ$$

7.22. Blade chords

From the foregoing, using the values quoted for $(s/c)_m$ and $(t/c)_i$ in 7·18

$$c_i^2 = \frac{ab}{\{10(t/c)_i\}^2} \cdot \sigma \left(\frac{s}{c}\right)_m \cdot \frac{h^2}{f_b} \cdot \frac{\Delta T}{10}$$

$$= \frac{0{\cdot}0414\, ab\, \sigma\, h^2 \Delta T}{f_b}$$

hence the blade chord at the root, c_i.

7.23. Stage widths

The blade stagger is given by $\zeta = \frac{1}{2}(\beta_1 + \beta_2)$ in the case of circular arc camber lines (see Fig. 10). Hence the axial blade width is $w = c_i \cos \zeta$. It is usual to take the stage width as $w_s = 2\frac{2}{3}\, w = (w_s)_1$ for first stage and $(w_s)_2$ for last stage.

7.24. Compressor length

The overall compressor bladed length, not including the inlet guide vanes is then (see Fig. 7).

$$L = \text{no. of stages} \times \tfrac{1}{2}\{(w_s)_1 + (w_s)_2\}.$$

To be continued.

Flame Hardening of Gear Teeth

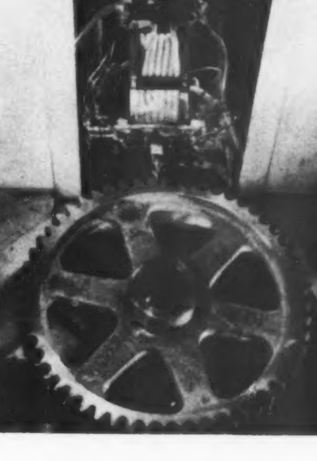
Radio-frequency equipment, specially designed for the surface hardening of gear teeth using oil-spray quenching, has been installed by Flame Hardeners Limited, of Bailey Lane, Sheffield 1. One advantage of this type of equipment is that it makes possible the hardening to high tonnages (up to 70 ton/sq in.) of such materials as alloy steel, notably En 19, 24, and 25.

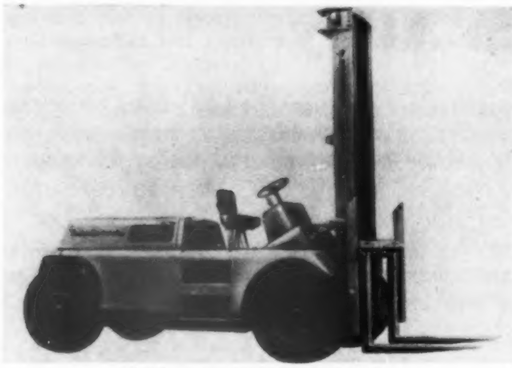
The operating principle is that very high temperature heat is generated locally at the surface of a metal by eddy currents induced by an alternating current in a nearby coil. The current employed alternates at the high frequencies normally used in radio transmission (450 kilocycles per second) and, in this instance, is provided by a 30 KVA generator. As the coil moves over, but not quite touching, the surface to be hardened it is followed by a spray of oil which quenches the heated surface. It is this rapid heating to high temperatures followed by immediate cooling to room temperature, that reforms and realigns the metal crystals in the surface of the metal and thereby hardens it.

The operating head of the equipment, made to Flame Hardeners' own design specification, is enclosed in a Perspex-walled box to prevent splashing of oil. When the coil has traversed the gap between two teeth, the gear being treated is automatically indexed one pitch and the movement of the coil is repeated in the next gap.

The mechanical linkage which controls the automatic rotation of the gear can be adjusted according to the size and design of the gear by varying a set of change wheels which cover all normal requirements up to a maximum of 3 ft dia and pitches from 6 dp to 1½ dp.

Induction hardening by the traverse method of a 24 in. dia 2½ dp gear using the new radio frequency equipment recently installed by Flame Hardeners Limited at their works in Bailey Lane, Sheffield 1





The Towmotor-Lansing Monarch A 24

Factory Trucks

The Towmotor Monarch A24 is a heavy industrial fork truck of new design, with a capacity of 24,000 lb at 24 in. load centres. It is one of a range designed specifically for heavy industrial use. Its large pneumatic tyres and ample under-clearance provide a means of moving heavy and cumbersome loads over very rough ground. It has a lifting speed of 50 ft per min loaded, and 75 ft per min empty. There are four forward and four reverse speeds giving up to 23 mph. Power steering aids its outstanding manoeuvrability, and automatic transmission is available if required.

The Lansing Bagnall Towtractor 700 is of entirely new design and primarily for use in confined spaces, particularly in factory areas where the lack of fumes and silent running associated with the electric drive are of major importance. The tractor has a nominal drawbar pull of 700 lb and is able to sustain this for speeds up to 3 mph. This means that loads of 7 ton or more can be hauled at appreciable speeds. It has a maximum speed, unladen, of 7 mph.

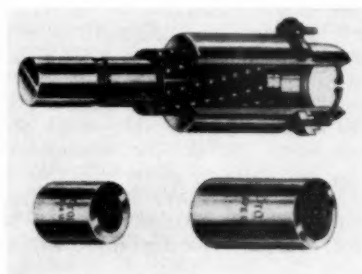
The Towtractor 2500 is a rugged yet highly manoeuvrable machine capable of producing a drawbar pull of 2500 lb at a speed of up to 1½ mph. Its nominal towing capacity is 25 ton, but lighter loads up to 10 ton can be towed at speeds of nearly 7 mph. The maximum speed unladen is 13 mph. Its series-wound traction motor of 10 hp at one hour rating gives it a remarkable gradient performance.

The Lansing Bagnall Rapide 4500 fork truck continues the trend in high-speed electric-powered machines which began with the Rapide 2000. With a capacity of 4500 lb at 24 in. load centres, the truck is able to travel at speed over rough and uneven ground and operate in confined and enclosed buildings where fumes would be detrimental to health. The triple mast system enables loads to be lifted a full 15 ft whilst still maintaining an overall lowered height of less than 7 ft.—Lansing Bagnall Limited, Kingsclere Road, Basingstoke.

The Towtractor 700

Linear Motion and Rotary Bearings

The design of Rotolin linear bearings is based upon the principle of freely rolling balls for friction free movement. These balls are contained within a retaining cage designed to provide scientifically controlled spacing and arranged on a helical pitch which ensures maximum point contact and sustained precision. The balls can be lightly preloaded while in contact, yet still remain free to rotate about their own axis, they thereby become slightly compressed causing a constant pressure to be exerted around the circumference between the bearing and shaft, which is, in effect, equivalent to a press fit. This condition has the effect of eliminating any small manufacturing tolerances which may be present and of positively restricting any lateral displacement to the limits of elastic deflection, whilst still permitting an exceptionally smooth and virtually frictionless movement by virtue of the rolling action of the balls between the bearing surfaces.



Three types of linear bearings made by Rotolin Bearings Limited, Kings Norton, Birmingham 30.

In consequence of this rolling action which is generated from the relative movement between the bearing and shaft, the balls travel on equal distance on the surface of each, thereby reducing the ratio of actual cage movement to one half of the total distance travelled. Therefore, for every inch of total movement, the ball retaining cage will only need to travel half an inch in the same direction.

These bearings have proved to be equally efficient for a great diversity of applications; they are capable of withstanding heavy loads and of operating continually at high speeds without any detectable trace of heat, wear or deflection and requiring only a minimum of attention to lubrication, yet they can also register the most sensitive movements for delicate instrument recordings.

The complete range of Rotolin linear bearings now being produced is divided into three main groups ranging in size from ¼ in. to $2\frac{1}{16}$ in. shaft diameters. Series-S is primarily designed for press tool die sets, Series-P for general purpose preloaded bearings, and Series-T for unlimited length of travel on long shafts. In addition there are, standard ranges of ball retaining cages as separate units for a great variety of special applications. In particular, they are very useful for experimental purposes or for making up special bearings for the replacement of damaged or worn cages in existing ball bushes or for use in the construction of special machine tools and mechanisms.

Properties of Tungum Alloy

The copper-based high strength alloy Tungum is widely used for pressure tubing in the aircraft industry. Comparable in strength with steel, Tungum tubing is currently finding increasing application for industrial hydraulics and pneumatics where a high resistance to corrosion is required and the expense of stainless steel is to be avoided. The non-magnetic and non-sparking properties of the material also offer advantages for tools and components produced as forgings, castings, or machined from bar stock, and employed in explosive atmospheres

ALMOST a standard material choice for pneumatic and hydraulic tubing for the British aircraft industry over the past twenty years or so, the copper-based Tungum alloy is finding increasing application in industrial hydraulics, pipework, etc., where its high resistance to corrosion and strength comparable with steel can be put to particular advantage. The mechanical performance of the original material has also been improved whilst a notable improvement in proof stress can further be obtained by heat treatment, without materially affecting the ductility.

Tungum is a copper-zinc alloy (81 to 86% copper), containing also aluminium (0·7 to 1·2%), nickel (0·8 to 1·4%), and silicon (0·8 to 1·3%). One of the most valuable qualities of the alloy is undoubtedly its high resistance to corrosion by a wide range of liquids or corrosive ambients. It is, for example, practically unaffected by salt water or saline solutions, resistant to most commercial acids and alkalis, dyestuffs and normally corrosive atmospheres (e.g. the products of combustion of coal gas). Nor does it suffer from hydrogen embrittlement.

As an engineering material Tungum is particularly attractive as having a strength comparable with steel, coupled with good resiliency and extremely good resistance to fatigue. Strength varies with the form and condition of the material, typical values being summarised in Table I. The stress-strain curve shows good linearity over the limit of proportionality, the leading parameter for stressing normally being the 0·1% proof stress which can be rendered as a minimum guaranteed figure for a specific form or size of the material.

Tensile strength tends to increase with a decreasing temperature, with normal ambient strength maintained up to about 300° C after which there is marked deterioration with further increase in temperature. Fig. 1 shows typical plot of ultimate stress against temperature for soft annealed Tungum sheet, the shape of the curve being fairly characteristic of the material in all other forms. There is a marked increase in ultimate stress at very low temperatures although the normal 'working' criteria—e.g. 0·1% proof stress, ductility, impact strength—remain substantially unaltered.

In tube form (solid drawn, seamless) for pressure rating the nominal U.T.S. of Tungum is of the order of 66,000 psi which with a safety factor of 3 gives a maximum permissible material stress of 22,000 for the purpose of calculating wall thickness. In practice, Tungum tubing for hydraulic work is rated on a safe test pressure basis representing a nominal maximum pressure which the tube can withstand without showing signs of distortion. In effect this implies 'sizing' the tube so that the test working pressure raises the material stress to the 0·1%

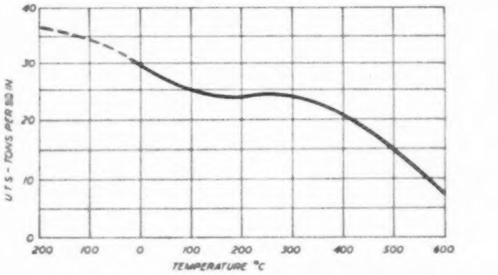


Fig. 1.—Typical variation of U.T.S. of soft Tungum sheet with temperature

proof stress (i.e. 33,300 psi) although in fact manufacturer's ratings tend to err on the conservative side—see Table II.

The theoretical bursting pressure can be taken as at least twice these ratings (thus for a safety factor of 3 the test pressure ratings can be factored by 2/3); although the ability to accommodate higher working pressures than the test figures implies that momentary pressures of this order could result in permanent deformation of the tube. This, in fact, raises a controversial question as to what is a safe test pressure for any hydraulic tubing (particularly non-ferrous tubing). A pressure test at a figure representing a nominal safety factor of 2, say, may prove ability to withstand twice the maximum design working pressure; but if the material has been deformed as a consequence of the test the actual safety factor available will have been reduced as a consequence. For this reason it is essential that proving test pressures should not be of sufficient magnitude to cause any yielding of the material and this is why even the 0·1% proof stress is considered by many authorities as too high for pressure testing. Where the would-be user is sometimes confused is in failing to appreciate the difference in stress levels which may be adopted for safe

Table I.—COMPARATIVE DATA TUNGUM SHEET, STRIP BAR, AND FORGINGS

Form	Condition	U.T.S.	0·1% Proof Stress	Ductility Elongation
		ton/sq. in.	ton/sq. in.	% on 2 in.
Sheet	Cold Rolled	24-50	—	—
	DTD 283A (annealed)	22-30	—	—
Strip	Cold rolled	30-60	—	—
	Spring hard	60	—	—
Bar	Rolled soft	30	15	50
	Rolled hard	46	34	17·5
	to DTD 319			
	up to 1 in. dia	35 min	18 min	20 min
	over 1 in. dia	30 min	15 min	25 min
Forgings	Cold forged	47·5-51	—	20-12
	Hot forged	32	—	30
Tube	Drawn, Seamless			
	Annealed	30 min	15	—

ratings and that an apparently low safety factor with a very conservative test rating may, in fact, represent a high overall safety factor.

The figure of 22,000 psi maximum permissible material stress for Tungum (consistent with an overall safety factor of 3) is directly, and favourably, comparable with steel hydraulic tubes, with the exception of the later stainless steels. Since the specific weight of tungum is greater than that of steel (0·304 lb/cu in. as against 0·283 lb/cu in.) the stainless steels also score on the account of total weight for a given service, but at the expense of a considerable increase in cost. Weight saving may outweigh initial cost difference in the case of aircraft, but for industrial applications the reverse is usually true. Thus where a corrosion resistant and/or high strength pressure tube is required, the properties of Tungum become attractive.

The maximum permissible material stress of 22,000 psi is consistent with Tungum tubes in the annealed condition. A considerable improvement in strength can be realised by heat treatment which can increase the 0·1% proof stress by as much as 25% without markedly changing the U.T.S. figure. In other words, whilst the apparent (overall) safety factor may not be increased (or only very slightly so) the raising of the 0·1% proof stress means that higher working pressures can be accommodated without encountering distortion. As a typical example a ⅜ in. o/d tube 20 swg wall showed a 0·1% proof stress of 16·6 ton/sq in. in the annealed condition and a 0·001 in. permanent distortion of diameter under a test pressure of 9,000 psi. After heat treatment the 0·1% proof stress was 20·2 ton per sq in. and the pressure to cause the same degree of permanent distortion well in excess of 10,000 psi. The manufacturer's test pressure rating for this size of tube, incidentally, is 6,500 psi in the annealed condition.

The ductility of Tungum tubing appears to be little affected by heat treatment although it is generally recommended that it should be manipulated in the annealed state and then preferably stress relieved to remove any residual stresses introduced by cold working, particularly in the case of tubes of ½ in. dia and above. Intermediate annealing may also be attempted where severe manipulation is called for, with all forming, bending, etc., done cold.

Although heat treatment is simple it can also be harmful if mis-applied, particularly in the use of a blowlamp or direct flame for local annealing. Annealing requires

Table II.—SAFE TEST PRESSURES FOR TUNGUM TUBES IN POUNDS PER SQUARE INCH*

(Based on maximum hoop stress of 33,300 psi and no distortion of tube)

Outside Dia.	WALL THICKNESS, SWG 12	14	16	18	20	22	24
in.							
⅛				25 000	19 000	15 000	11 750
3/16			23 000	17 000	12 500	10 000	7 800
¼			17 000	12 750	9 500	7 500	6 000
5/16			13 500	10 000	7 500	6 000	4 700
⅜			11 500	8 000	6 500	5 000	3 900
7/16			9 750	7 250	5 500	4 250	3 300
½	13 750	10 500	8 500	6 450	4 750	3 750	2 900
⅝	11 000	8 500	6 750	5 000	3 750	3 000	2 400
¾	9 250	7 100	5 750	4 250	3 200	2 500	2 000
⅞	7 750	6 100	4 900	3 700	2 750	2 150	1 650
1	6 900	5 300	4 250	3 200	2 400	1 850	1 450
1¼	5 500	4 250	3 400	2 500	1 900	1 500	1 150
1½	4 600	3 500	2 800	2 100	1 600	1 250	1 000
1¾	3 950	3 000	2 400	1 800	1 350	1 050	850
2	3 450	2 650	2 100	1 600	1 200	950	700
2¼	3 050	2 350	1 900	1 400	1 100	850	650
2½	2 750	2 100	1 700	1 250	950	750	600

* The Tungum Company Limited.

heating to a temperature of between 650° to 750° C and the temperature maintained for a period which may extend up to one hour, according to the mass of material involved (but invariably much less in the case of tubes). The material should then be left to cool slowly and not quenched. Overheating will ruin the material and as a general guide for local blowlamp work anything brighter than a dull red heat is excessive and could be harmful.

Stress relief is provided by heating to about 300° C for a period of not less than ten minutes and then either quenching or allowing the material to cool naturally, whichever is the most convenient. Heat treatment for maximum mechanical performance involves heating to 450° C for one hour followed by immediate quenching in water—typical precipitation hardness treatment.

In sheet and strip form Tungum alloy has a U.T.S. figure of approximately 22 ton/sq in. in the fully annealed condition, up to 50 to 60 ton/sq in. in the fully hard condition (the latter corresponding to 'spring hard' strip). Hard strip is particularly useful for springs or spring pressings for electrical or mechanical operations where corrosive conditions are present and will show a virtually indefinite life. The fibre stress is higher than that of other non-ferrous spring materials such as phosphor bronze. Springs are also wound from the wire form of the alloy with U.T.S. values up to 75 ton/sq in.

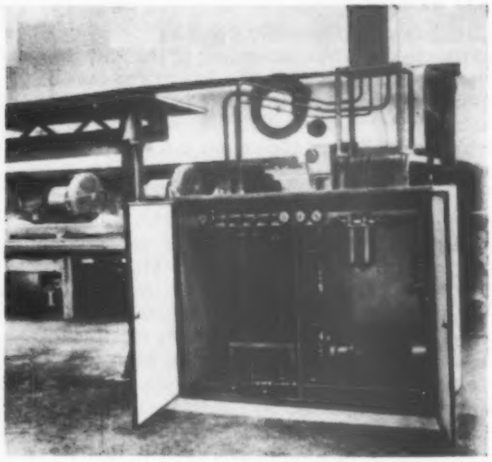
Bar stock is produced in extruded, rolled or drawn bar which has good machining properties using either high speed steel or carbide-tipped tools. Paraffin coolant is normally recommended with H.S.S. tools. Machining with carbide tipped tools can be done dry, or with coolant. The deciding factor in this case is usually the surface temperature likely to be reached as excessive local heating may be harmful, as already noted.

A comparison between the hardness range possible with solid stock is given by the following figures. As cast a hardness figure of 56 Brinell is typical. For rolled soft rod or bar a typical figure is 80-85 Brinell. Rolled hard the figure may rise as high as 200 Brinell. Again, of course, heat treatment may be employed to anneal, stress relieve, or precipitation harden the material.

Castings, of course, do involve raising the temperature of the alloy above the nominal "maximum safe" temperature. The melting point is 1008° C and the normal pouring temperature about 1100° C. Fairly strict temperature control is needed to avoid overheating which could cause the more volatile metallic constituents to be boiled off, and the melt should not be left to soak at the pouring temperature.

The rate of shrinkage is high—approximately 3/16 in. per foot on any linear dimension, and due allowance must be made for this in pattern design. Castings left to cool in the mould will automatically self-anneal and come out in the fully soft state. If broken out of the mould and left to cool in the air they will develop a certain surface hardness and further skin hardness can be produced by chilling.

The ductility of Tungum is such that it can normally be cold-worked to a considerable degree (with intermediate annealing, if necessary) but the material is equally suitable for hot pressing or forging. In this case the recommended working temperature for hot working is 750° C (and should never exceed 800° C). A hot forging or pressing will self-anneal on cooling and thus show lower U.T.S. and hardness than a cold-worked stock. Typically, a hot forging will show a hardness of 110 to 130 Brinell and a cold forging a hardness of 200 to 220 Brinell with up to 50% increase in U.T.S.



The billet grinding machine in operation and (at left) the complete power pack assembly for operating the hydraulic equipment

Controls for Billet Grinding

In any hydraulic installation the size of motor-pump unit required will largely depend upon the speed of the operation and the maximum demands likely to be made upon the system. Where these demands are apt to fluctuate widely or a speed of operation is required which does not have to be limited by the output of the pump the use of a hydraulic accumulator, or even a number of accumulators, is usually recommended. Such an installation is typified by the hydraulic system designed and supplied by Lockheed Precision Products Limited for the operation of the special steel billet grinding machines at the Cambuslang, Scotland, steelworks of the Clyde Alloy Steel Company Limited, one of the Colville group. These machines, the first of their kind to be employed within the United Kingdom, have been manufactured and installed by the Swedish firm of A.B. Slipmaterial-Naxos with the object of reducing costs and speeding output by enabling surface defects to be removed at the bloom stage, instead of the more common practice of waiting until the billets have been rolled down to the smaller sizes.

Controls for the treatment of the 15-ft. long blooms are so arranged that grinding can be carried out automatically on all four surfaces in turn or, where deeper imperfections have to be removed, by spot dressing using hand control. Each machine has three power-driven grinding heads which can be set to operate together, in pairs, or individually as required, and the grinding of the blooms can be carried out longitudinally or crosswise, in step or zig-zag fashion. All these various movements are selected by the operator in charge of the grinder, who is seated at a control desk in front of the machine.

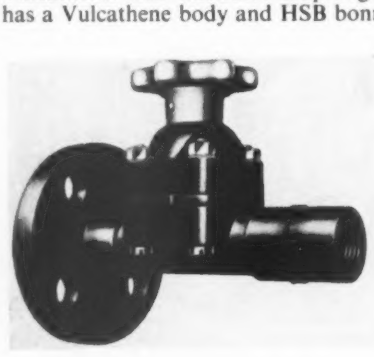
Power for the control of the various movements is provided by two large gas-charged accumulators (each with two auxiliary bottles attached) supplied by a motor-driven pump which draws fluid from a 20-gall supply tank through a two-stage PurOlator Micronic filter and delivers it through a cut-out valve.

Each grinding head has a hydraulic cylinder to feed it to the work. A constant pressure of 850 psi is applied to the annular side of the piston and a variable pressure of 350 to 850 psi at the full area side, the combination giving a controllable force on the wheel of from 0 to 800 lb. Operation is by solenoid valves actuated from the operator's desk. Two cylinders operate the traversing movements of the overhead crab and carriage, controlled by levers on the desk and automatic reversing valves and transfer cylinder so that each reciprocation of the head is followed by an inching movement which causes the grinding heads to traverse a fresh path along the bloom. The control valve which governs the measured amount of fluid transferred has a 10-positional setting so that the degree of inching can be closely governed.

The bloom is held to the table by hydraulically-operated clamps and these also are controlled from the desk. When a bloom has been finish ground on one of its surfaces the operator moves the control lever which allows the clamping cylinders to retract. By operating a further lever fluid is drained from cylinders beneath the work table and the table descends and as it does so one edge of the bloom contacts a fixed stop which causes it to tip over. The lifting cylinder then raises the table and the clamping cylinders lock the bloom in position for grinding the new surface.

Corrosion-resisting Valves

To resist corrosion in chemical plant applications, valves made by Saunders Valve Company Limited, Cwmbran, Mon., are made in a variety of materials such as cast steel, stainless steel, with glass linings, and with ptfe diaphragms. Additional body materials and linings include solid ptfe, Penton, rigid PVC, HSB and Vulcathene. The Saunders diaphragm valve illustrated has a Vulcathene body and HSB bonnet.



Saunder diaphragm valve with Vulcathine body and H.S.B. bonnet

Further Developments in Nickel

In two previous articles (November 1961, February 1962) the writer gave particulars of some of the more important developments in nickel research. The account is now brought up to date with additional details

FROM the point of view of thermodynamics it is generally taken as a fact that the copper nickel system is ideal for the study of oxidation. Both metals are jointly soluble throughout the entire range of compositions. One is more active when oxygen is present than the other, and the respective oxides are, furthermore, insoluble in each other. Not enough work had been done, however, on the behaviour in relation to oxidation of the intermediate copper-nickel alloys, so a series of investigations was carried out to enlarge knowledge in this respect. During isothermal oxidation it was found that two oxide layers are formed, an outer copper oxide layer and an inner layer of copper oxide and nickel oxide. The method of growth of these layers was theoretically explained and recrystallization of the outer copper oxide layer was found to play an important part.

It was known that the effect of the atmosphere on the creep-rupture properties of nickel in air and vacuum varied with the rate of strain. Metals were also known to have better creep strength in air than in vacuum at the low strain rates used. Nickel also had a longer rupture life in air than in vacuum. When high strain rates were involved, however, the position was reversed, creep properties being better in vacuum. To explain these results it has been suggested that two competing processes are involved, namely oxidation strengthening and reduction of strength by decrease in surface energy.

The relationship of oxidation properties to atmospheric effect was studied, using a nickel chromium alloy of higher resistance to oxidation, and also the influence of air and vacuum on the alloy as compared to nickel.

It was found that the alloy was stronger in air than in vacuum at high temperatures and low strain rates, but the reverse obtained at low temperatures and high strain rates. The reversals in behaviour took place at shorter times at the higher temperatures. At prolonged high temperatures a marked strengthening and increase in ductility occurred. Possible mechanisms to explain these reversals were presented, one being the strengthening caused by oxidation and the other the decline in strength caused by surface energy reduction. The activation energy for creep of the nickel chromium alloy was about 88,000/cal/mol.

An attempt has been made to derive practical multiplying factors for hyper-eutectoid steels austenitized at 925° C. These data help to determine the ability of case-carburizing steels to be hardened when directly quenched from this temperature. The effects on case-hardenability of numerous alloying elements had earlier been found in steels containing between 0·2 and 0·7% carbon. Nickel is one of the alloying elements recently investigated, singly and in combination with other elements, in 1·0% carbon steels. The steel was quenched at 925° C from prior structures of both normalized and spheroidized type. Two different sets of hardenability factors were derived, one set based on a normalized prior structure for case-carburizing steels with carbon contents ranging from 0·75 to 1·25%, and the other, based on a spheroidized prior structure, for steels such as tool steels. The hardenability factor for nickel was obtained at a level of 1·5% or higher. The influence of nickel is independent of prior structure, and the element has a low hardenability effect as compared to other elements. Its influence remains about the same at 925° C as for lower temperatures.

Low cycle fatigue in metals limits greatly the service life of constructions and machines, and must be taken into account by design-engineers. Innumerable practical instances exist of cyclic thermal stress or cyclic strain factors being of importance in aircraft, power plant, motor vehicles, gas and steam turbines, and constructional plant. Work has been done in the past on both thermal and mechanical fatigue areas. Recently, however, the pertinent available data have been summarized and the simplicity and regularity of the facts when represented by relating the plastic-strain range and the number of cycles to failure revealed. The significance of the fracture ductility in predicting cyclic strain fatigue resistance has also been investigated. Stainless steels containing nickel were used for the research. It was indicated that a plot of the logarithm of the plastic-strain range versus the logarithm of the number of cycles to failure with a straight line of slope equal to $-\frac{1}{2}$ is valid. Within a reasonable degree of error this type of fatigue curve can be plotted after obtaining the fracture ductility of a metal or alloy in a simple tension test.

Early in the study of thermal cycling and its influence on engineering materials, it was discovered that a brittle material behaves differently from a ductile one, the brittle materials enduring only a small strain before rupture, whereas the ductile could be thermal cycled many times and absorb the plastic strains, fracture occurring only if these strains were severe and often repeated. There has therefore been much research into the thermal and mechanical fatigue of nickel. It seems as a result that the element can absorb much greater stresses in load cycling than in thermal cycling for the same relation of service life to failure. This work fills a serious gap in the closer understanding of the relation between thermal and mechanical cycling behaviour of metals. The work was done on thin-walled tubes under stress at a constant mean temperature. Grain size seems to have little effect. At higher temperatures than those of the test (300° and 275° C) it is possible that the grain size may play a larger part.

The activation energies for creep of polycrystalline nickel have been obtained by a technique involving the nifluence of a sharp change in temperature on the rate of creep. It was previously known that the creep behaviour of polycrystalline alloys depended on time and temperature in accordance with a functional relation represented by an equation, but it was deemed advisable to study more thoroughly the actual activation energies for creep of face-centred cubic nickel as a means of illuminating the intermediate and low temperature mechanisms of creep. It was hoped that this might help to identify the rate-controlling mechanisms that might be active.

In general, the activation energy for creep was found to increase with increasing temperatures from a low value of about 3000 to 5000 calories per mole at 78° K to that for self-diffusion at the highest temperature.

High strength nickel-base alloys containing molybdenum have a wide range of uses in the petroleum, petrochemical and chemical industries as materials for heat exchangers, towers, vats, vessels, tanks etc. Although mainly designed for resistance to hydrochloric acid, they show excellent corrosion resistance to other reducing chemicals and acid chlorides, as well as to sulphuric, phosphoric and acetic acids. A proprietary alloy of this type having a nominal composition of 28% molybdenum, 5% iron, and a balance of nickel for service up to 650° F has been formally recognized, and therefore its behaviour in conditions leading to creep and its exceptional resistance to the corrosive attack of some non-aqueous environments at elevated temperatures have made it attractive for use in nuclear reactors.

It was determined, therefore, to discover the weldability of this alloy and of the properties of welded joints at the temperatures of potential application. It was also considered desirable to obtain more data on the type and occurrence of ageing and its effect on the mechanical properties of the wrought metal for purposes of comparison. It was found that precipitation occurs at all the temperatures investigated (595°, 700°, 815° and 870° C). At 595° C the precipitation is evident through changes in hardness and mechanical property values. At 700° C, a special type of precipitate develops rapidily, causing marked increase in hardness and a significant decrease in tensile ductility. This precipitate persists at 760° C, but is replaced by a needle-like precipitate at 815° C and appears at temperatures up to 900° C. This last precipitate damages the tensile ductility much less than the special precipitate. Ageing results in a relatively small improvement in the room- and elevated-temperature tensile strength, accompanied by a marked reduction in ductility at both temperatures.

Experimental difficulty in measuring exactly the austenite transformation during continuous cooling has led investigators to study the transformation of austenite as it occurs isothermally and on continuous cooling in a nickel chromium molybdenum steel, with carbon content such that neither pro-eutectoid ferrite nor pro-eutectoid carbide was formed. The result was the production of a cooling transformation diagram, a precise isothermal transformation diagram, and a study of incubation effects.

The effect of changes of structure on the density of metals and alloys has been the subject of great attention. Some solid state reactions, for example precipitation from solid solution, are known to promote expansion or contraction in alloys. However, the effect of these changes of volume on the creep behaviour of alloys has not been thoroughly studied. It was decided therefore to clarify two aspects of 'negative creep' for the purpose of deciding whether the true amount of plastic deformation and the observed creep strain can be calculated from crystallographic data and known phase relations. It was also decided to determine by experiment the influence of a negative volume change under the constraint existing in a stress relaxation test.

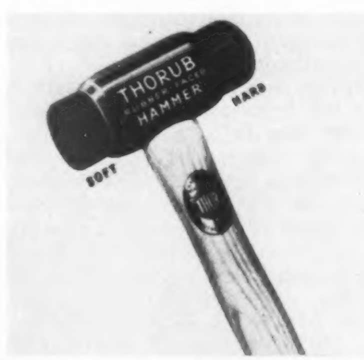
In nickel molybdenum alloys of certain compositions it has been shown that the amount of contraction can be calculated from the known phase relations and crystallographic data. Under imposed conditions of constant strain, the contraction of these alloys may not only retard stress relaxation, but may also lead to a marked increase in the initially applied stress. What this means in effect is that the phenomenon known as 'negative creep' exists, and it opens up the possibility of designing non-creeping alloys.

A new method has been found for producing crystals of nickel oxide. The crystals are produced by elevated temperature decomposition of metal halide in an atmosphere which has hydrogen and water vapour in the proper ratio to be in equilibrium with the monoxide phase of the metal. The single crystal oxide film is as large in area as the substrate magnesium oxide crystal on which the metal halide decomposition occurs. This single crystal grows to a thickness determined by the quantity of reactants supplied to the surface. Oxide crystal films of nickel oxide (and other metallic oxides) 500 microns in thickness have been produced. This research represents an important contribution to both crystal preparation techniques and to the understanding of crystal growth. The method may be extended to materials for which evaporation or electrolyis are unsuitable.

The effect of trace elements on the properties of nickel is extremely interesting to producers and users of nickel and its alloys. Little information existed because high purity nickel containing controlled additions is difficult to prepare. These difficulties, have now been overcome and it appears that the greater the increase in atomic diameter of the added element with respect to that of nickel, the higher the recrystallization temperature, the greatest increase resulting from adding the largest atoms, magnesium and zirconium. With the continuing emphasis on greater reliability and tighter specifications in alloys for mechanical, electrical and magnetic applications, the need for understanding the influence of alloying and 'tramp' elements has increased.

Maintenance Packing

Two packings that will handle practically every packing job and give long life and economise in stock keeping are 'Chempac' (P.T.F.E.) White and 'Thermocore' Black introduced by Johns-Manville Company Limited, 20 Albert Embankment, London SE1. 'Chempac' is a combination of asbestos and Teflon and is for pumps, agitators, expansion joints; and 'Thermocore' is for valve stem packing, including steam at 1200° F and 500 psi. This packing consists of a braided jacket of 95% pure asbestos yarns, each yarn having an Inconel wire insertion, over a core of asbestos and graphite.



RUBBER-FACED HAMMER.—The new Thorub hammer made by Thor Hammer Company, Highlands Road, Shirley, Birmingham, has hard and soft rubber renewable faces. The hammer is particularly useful for metal shaping and whenever it is essential to avoid damage to the work. It is made in 1½ in. (1½ lb) and 1¾ in. (2½ lb) sizes

In the new Scott-Wemco torque-flow pump a recessed impeller, located completely out of the flow pattern, imparts a swirling action to the material in transit causing suction and discharge to become one continuous open passage from inlet to exit flanges

Sludge Pump

The Scott-Wemco torque-flow pump incorporates a new principle of construction which enables it to handle, without any clogging, a diversity of difficult materials. A recessed impeller, located completely out of the flow pattern, imparts a swirling action to the material in transit, causing suction and discharge to become one continuous open passage from inlet to exit flanges. Particles and solids are drawn into the swirling vortex and discharged with a centrifugal sweep from the open chamber, seldom even touching the impeller.

Sludges and slurries of high solids content, tough abrasives, soft, sticky or fibrous materials can all be handled swiftly and efficiently, and the pump can deal with comparatively fragile substances also because there are no violent directional changes or confined passages in the flow area.

A feature of the new pump is the minimum maintenance involved and the simplicity of the construction allows for quick and easy dismantling and replacement if necessary.

Paper and wood pulp, crushed bones and shredded hides for the gelatine industry, coal slurries, sand, gravel and minerals, all in the form of suspensions, can be handled with equal facility. Another feature is in the handling of crystalline slurries where there is little or no degradation of the crystals since the impeller seldom touches the material being pumped. Certain fruits and vegetables have also been pumped in a suspension of water for transport from the receiving department to the processing department, without damage to the materials. —George Scott & Son (London) Limited, Levenbank, Leven, Fife.

Spraying Nozzles

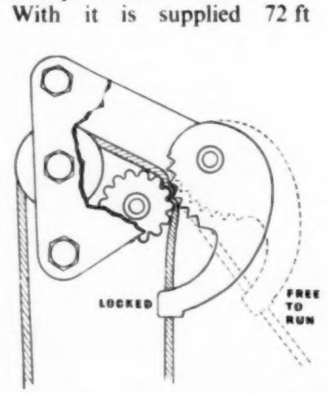
Alfred Bullows & Sons Limited, Long Street, Walsall, recently introduced four new air nozzles for use with their L.540 and L.1900 spray guns. Air and material nozzles on both guns are interchangeable.

The first of the nozzles, the 63PH2, was developed in conjunction with the Binks Manufacturing Company of Chicago to meet the need for a nozzle suitable for use with the acrylic resins now being used in this country. The second nozzle is the 66PD in which the air ports are arranged so that air passes tangentially across the face of the nozzle, thereby using the full kinetic energy of the discharged air. This provides a wide spray and maximum coverage per pass of the gun with minimum consumption of air at minimum pressure. The third, the 66SD, is designed for use with the suction feed set-up. Using low air pressure it gives a high performance with fine atomization. The fourth is the 68PM, a mistless nozzle intended for conditions calling for low pressure spraying; for instance where exhaust facilities are inadequate and overspray must be reduced to a minimum.

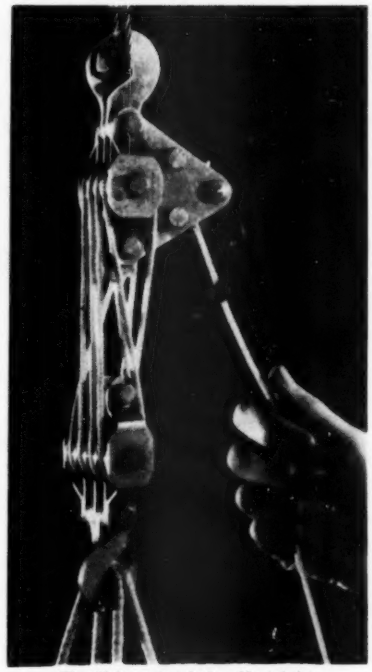
Midget Hoist

The Haltrac Autolock midget hoist can be used for lifting, hauling or dragging purposes and combines ease of operation and economy of effort. Compact in size, it is made of specially tempered aluminium together with high tensile plated steel bolts, nuts and washers, and eight nylon pulley wheels. Weighing 1½ lb it can fit into confined spaces, tool box, or car boot, and is rustproof and requires no lubrication.

With it is supplied 72 ft of braided nylon cord giving a lift of 9 ft, which, passing through eight pulley wheels, gives an 8:1 reduction. The equipment has been tested to a breaking strain of more than 1000 lb on a straight lift. It can move a car, trailer or caravan weighing up to 2½ ton.



Diagrammatic view of Autolock device on hoist



The Haltrac Autolock midget hoist

The hoist is simple in operation. When a load is pulled at an angle the cord runs free; if released, the cord is instantly held between toothed nylon cams. A sideways pull, and the load is free again.

The hoist is priced at 87/6, without the Autolock 57/6. The manufacturers are Haltrac Limited, Bourne Works, Weimar Street, London SW15.

Swarf-proof Gloves

In the handling of swarf many cuts of a minor nature occur which in themselves may not be serious but which can lead to painful discomfort and impaired efficiency for the operative who handles this waste material without proper protection. Northide Limited, P.O. Box No. 5, Hyde, Cheshire offer P.V.C. gloves to combat this hazard, which whilst allowing excellent manipulation to the wearer, protects him and resists the cutting edges of the swarf for a considerable period.

Production Practice:

Machining Pressure Cooker Bodies
Internal Countersinking
Drilling Holes through Hexagon Nuts

By JOHN WALLER

THERE are occasions when the size and flimsiness of a casting make the question of holding it in the machine a matter for careful provision. Fig. 1 illustrates the body casting of a pressure cooker, the essentially thin walls of which reduce weight and obviously assist handling when using the assembled article, but which raise machining problems when the inner surfaces are bored as the lack of metal in these walls can set up severe chattering and so mar the finish.

Fortunately these bodies are die cast and their accuracy is useful in ensuring correct location. Two points are used—the outer ring A which is machined away to locate underneath the tapered portion of the body rim, and spring loaded while being able to slide the four case hardened pins B. Bushes C are similar to those used on pillar type press tools. Secondary location is on the tapered bore of plate R which also provides support at the lower end. This plate is also spring loaded because it must assume a varied position each time a casting is machined due to slight errors on the surfaces.

As both rings are thus floating on their pins a series of hexagon studs S with locknuts are incorporated to provide a seating for the casting. The clamping details J and H thus pull the component toward the faceplate until all movement ceases and a solid assembly is obtained. The two rings A and R are not locked in any way.

The clamping mechanism embodies an unusual feature. A heel H is attached to sliding rod J by means of a pivot pin, and on moving the clamp away from the fixture the heel can pivot due to the presence of the small pin L. The latter is arranged to actuate the heel through the medium of the slot milled radially in the side; thus there is a swinging movement about the pivot pin and so away from the ledge cast on the body. A pneumatic cylinder at the rear of the machine imparts the necessary motion through the centre of the machine spindle.

This operation was done on an automatic lathe and a sub-faceplate was made with three slots milled through into the bore (Fig. 3). The three pronged sliding plate M covers the centre of the sub-faceplate and provides a site for the pneumatic cylinder piston.

A sheet metal guard G enshrouds the assembly and enables the operator to observe the cutting operation without danger. It also excludes swarf. If drain holes are needed they are drilled about $\frac{1}{8}$ in. dia at three or four places round the guard.

In view of the large production schedule the various moving parts of this assembly were case-hardened. The fixture rotated at approximately 1000 rpm and carbide tools were used for the taper boring and facing of the bottom surface. The cut was continuous and necessitated the removal of about $\frac{3}{64}$ in. per surface, the lathe being designed to carry a large auxiliary tool slide for the purpose with a feed of about 0·025 in. per revolution. The slide is hydraulically operated and controlled by a taper bar on the rear of the bed. When the slide reaches the limit of the longitudinal travel it contacts a stop and

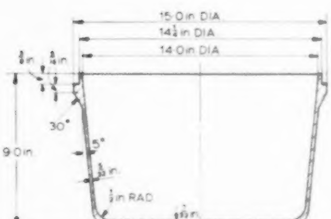
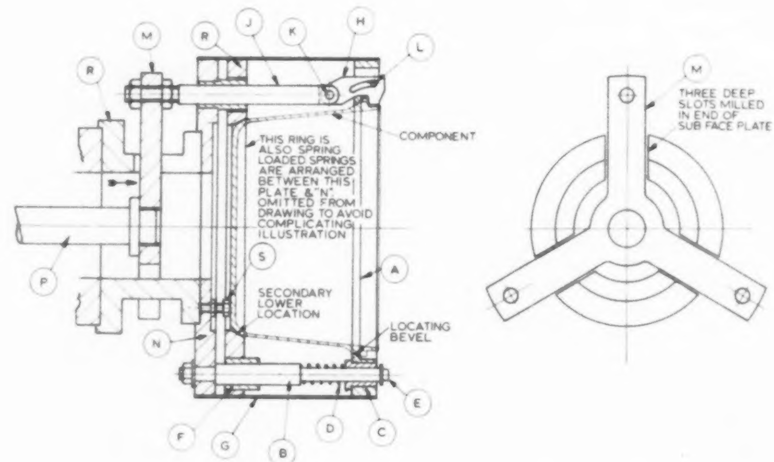


Fig. 1. Clamping problems often arise with components like this and the possibility of vibration makes a special fixture essential. Material: aluminium diecasting



Figs. 2 and 3 (right).—Fixture for holding pressure cooker bodies while machining and (Fig. 3.) view in direction of arrow showing method of assembling sliding plate into sub faceplate

moves away from the bar toward the machine centre and faces the lower surface of the casting. On reaching the centre position the tool is returned to the starting position ready for the next workpiece and well clear of the loading station.

Some chatter occurred to start with but was overcome by attaching thick sponge rubber pads on faceplate N and pulling the casting back on to them. Cutting time was approximately 40 sec and floor to floor time about two minutes.

Usually very little machining other than drilling and countersinking is required on sheet metal components but there are occasions when even the latter simple operation can create difficulties and the example seen in Fig. 4 shows where special tooling equipment is necessary.

Several hundred channel shaped details were needed for an accounting machine contract, but due to error the parts were bent to shape and the countersink omitted from inside the channel. The lack of a hole directly opposite prevented the use of a long tool passing through the side wall. Reverse countersinking was tried but removing the tool from the chuck, threading on a workpiece and then endeavouring to form the angle by lifting the drilling spindle proved a lengthy job so the decision was taken to make a special countersinking head.

A small peg through the drilled hole provided location and was spring loaded so that it moved down as the tool came into operation (Fig. 4).

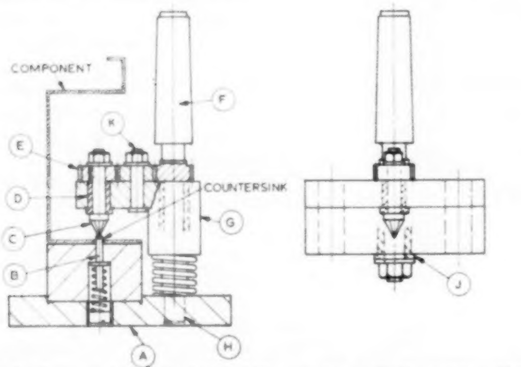


Fig. 4. Small countersinking attachment which overcame a production problem which brought work to a standstill.

As the countersink was small the shank was used as a shaft with a tiny key at the top to obtain a drive from the gear E. The driving gear F was turned and cut integral with its shank and extended down to run in the bronze bush J driven into the main bearing block G. The idler gear and shaft K gave a drive in the same direction as the taper shank and as all the gears were of the same diameter the machine spindle revolutions corresponded to the countersink speed. Block G slides on two pillars.

Limiting the depth of the countersink was secured by the machine spindle stop. The production rate was high because both hands were free and no clamps needed tightening.

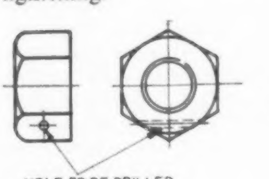


Fig. 5. A hole drilled through the sloping side of a nut is a typical example where an apparently simple looking job requires close support

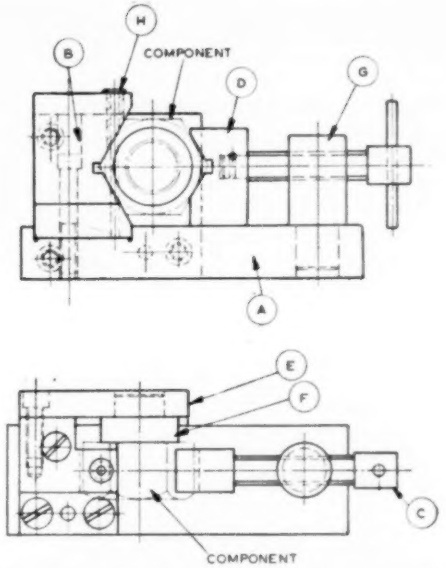


Fig. 6. This jig offers support to the drill and ensures true and easy start. Clamping is simple and the location is easily cleaned of swarf and coolant.

The drilling of a hole through the sloping side of a component is not a difficult task to perform and there are many occasions when a bush is incorporated in a jig for this purpose in addition to the others which are necessary for those holes that pierce the detail in the normal manner, and in all instances a bush closely set to the hole edge is essential.

One particularly awkward case where this type of hole occurs is in hexagon nuts where the hole is eventually used for a sealing wire to prevent tampering with the mechanism of an instrument. Again, a similar design is found when a pin is assembled through a nut to act as a retainer is some clamping mechanism of a machine, and the steep slope means that even a small distance of as little as $\frac{1}{32}$ in. causes the drill to judder until the cutting edges are both cutting properly.

Fortunately, with simple hexagon nuts, Fig. 5, the drilling of the hole is an easy task with a drill jig, and a typical piece of equipment is depicted at Fig. 6. A base A is machined from a mild steel strip and this carries the locating member B—the usual array of dowels and screws holding it to the base detail— and behind the locator is another member E that serves to position the nut in a sideways direction.

A screwed stud C on which is secured the usual rotating head D completes the design, and the elevation reveals that the nut fits snugly into the V, and the passage of the drill is merely a formality. One further feature of importance is the fact that the nut is easily removed from the jig—in this case, pushing it on to the back location is done with the fingers, but the addition of some further clamping medium does not interfere with the easy loading capabilities of this equipment. Perhaps the most significant provision in the design is swarf disposal as the open nature of the V and the absence of any elaborate clamping device allows an operator to blow the chips clear or to sweep them away with the aid of a brush in a matter of seconds; thus if the base is clamped to the machine table with the bush directly underneath the spindle, loading, drilling and unloading these nuts is a very simple task.

Machine Tool Record

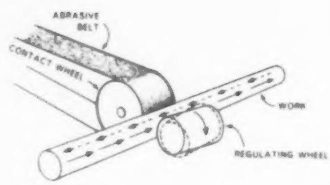
Abrasive Belt Grinding

On Sundstrand Engelberg machines, workpieces can be accurately sized and finished to exacting specifications. Tolerances of 0·001 in. or less and finishes to 4 micro-inches are readily obtainable. Optional automatic size control which is available on all models holds tolerances as close as ± 0·0002 in. Four models

Accurate sizing with high finish is characteristic of Sundstrand Engelberg abrasive belt machines. The sketch below shows the action of the regulating wh el in feeding the work

for handling solid bar from $\frac{1}{16}$ in. to 9 in. dia and tubular stock up to 12 in. dia are manufactured by Sundstrand Machine Tool, Belvidere, Illinois, U.S.A. Sole U.K. selling agents are Rockwell Machine Tool Company Limited, Welsh Harp, Edgware Road, London, NW2.

Sundstrand Engelberg machines have been supplied for grinding such widely different materials as stainless steel and nylon and for components varying from socket wrenches to large paper machinery rolls. Centreless abrasive belt grinding has many advantages including fast stock removal, no wheel truing or dressing and constant surface speed of the abrasive. The Model 6120 machine is shown here. It is the second smallest of the range and handles solid stock from $\frac{1}{4}$ in. to $3\frac{1}{4}$ in. dia and tubing up to $4\frac{1}{2}$ in. dia. It uses a 6 in. × 120 in. abrasive belt driven at a surface speed of

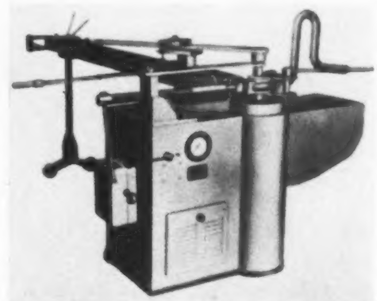


4500 fpm by 15 hp or 25 hp motor. The 6 in. × 14 in. dia rubber covered contact wheel is sufficiently flexible to compensate for stock irregularities. Belt tensioning is through a pneumatic cylinder.

Screwing Die Grinding Fixture

A series of fixtures for holding Coventry dies for re-grinding has been introduced by Alfred Herbert Limited, Coventry. They can be clamped to the machine table by T-bolt or mounted on a magnetic chuck and any throat or rake angle can be obtained by inserting dies in their correct position in the fixture. The trunnion on which the dies are held is rotated to the required angle and clamped by two large thumb screws. The rake or throat angle is ground simultaneously on all the dies of a set. When grinding the rake angle only one die need be measured in the height gauge as all the others in the set will be identical. Both left and right hand dies can be ground in the same fixture.

In the new fixture all the Coventry dies of a set are ground together



Lang bending machine for thick and thin walled tube

Tube Bending Machines

With the introduction of two new machines to the range of Lang electro-hydraulic mandrel type tube bending machines, all sizes of thick and thin walled tubes of up to $6\frac{1}{2}$ in. o.d. are covered. The two new machines are the model UNI-M1-US, with a capacity of $2\frac{3}{8}$ in. o.d. and mandrel length of 68 in. and model UNI-M1A-US, with a capacity of 3 in. o.d. and a mandrel length of 80 in. The minimum radius bent on the small machine is 14 in. and on the larger machine, 16 in.

These machines will bend cold, without filling, and within their capacity, all kinds of steel, copper, brass and aluminium tubes, and gas, water and steam pipes, by the use of a mandrel, equal in size to the inside diameter of the tube.

The speed of the bending arm is infinitely variable in both forward and reverse, so that the machines are particularly suited for either single-piece, batch or mass production, with times to match each requirement.

Progressive Dishing

Following the introduction of a pneumatic progressive dishing press for forming thin plate dished ends, Reed Brothers (Engineering) Limited, Replant Works, Woolwich Industrial Estate, London SE18, are now marketing similar presses of increased power and hydraulically operated, capable of forming by the progressive method, plates of much greater thickness.

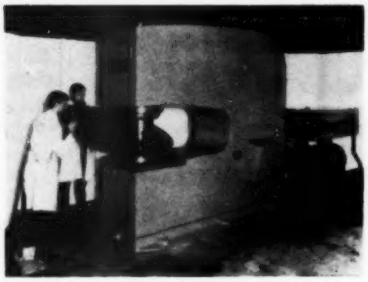
The range is increased by the introduction of 50 ton and 100 ton presses, the 50 ton unit being capable

of producing high quality dished ends in mild steel plates up to $\frac{1}{2}$ in. thick 8 ft dia, and the 100 ton unit, dished ends in plates $\frac{3}{4}$ in. thick and 8 ft dia, all plates being cold worked. The photograph shows a dished end being formed in the builders works.

Although the presses are primarily marketed for plate dishing, they are equally suitable for performing general press and hot forging work, the latter particularly as the press is capable of operating at speeds up to 100 strokes per minute. For flanging work, pillar type guides and crosshead can be supplied.

Hydraulic power is supplied from a self-contained pumping system operating with oil as the pressure medium, and is complete with motor starter.

Control is by foot pedal, and as a



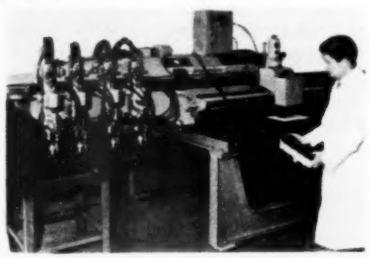
Reed progressive dishing press

repeater system of control is incorporated the press will cycle so long as the pedal is kept depressed. Adjustment of operating speed can be easily and quickly carried out over a range from 12 to 100 strokes per minute. Cyclic control is also available.

Profiling Height Control

The Hancoline oxygen profiling machine, manufactured by Hancock & Co. (Engineers) Limited, of Progress Way, Croydon, has now been improved by incorporating in it an automatic height control unit. A small electronic unit is fitted in a sheet-metal case mounted on top of the machine. A remote hand control switch-box is attached to it and the switch-box is mounted with special clips so that it can be positioned anywhere along the burner bar. The box has one switch for each burner which either raises the burner to its maximum height or lowers it until it senses the height of the plate to be cut. With the switch in the automatic position the burner maintains a constant height above the plate during cutting.

The burner is raised and lowered by a small fractional horse-power motor connected to a lead screw in a fully enclosed mechanism attached to the vertical slide of the machine.

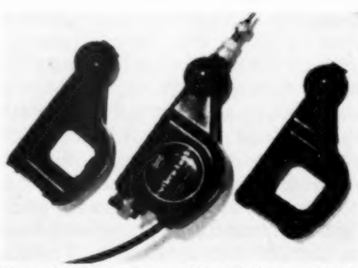


This oxygen profiling machine is the first to have a new automatic height control attachment which increases the cutting efficiency in comparison with manual height control

Three electric cables run between the motor and the control-box in one plastic sheath. A separate co-axial cable passes from the control-box to the circular ring round the bottom of the nozzle. The capacity variation between the ring and the material beneath the burner, through the electronic control, causes the motor to revolve in one direction or the other and the burner to raise or lower.

Vibro-Tool

The new Burgess Industrial Model Vibro-Tool is a multi-purpose electrically operated hand-engraver capable of all kinds of marking operations that are outside the scope of electro-arc etching machines. Not only will it engrave ferrous metals (of all hardnesses) but will permanently mark all other kinds of hard surfaces, such as brass, plastics, glass, ceramics and hardboard. It is suitable for clearly marking code or part numbers on small components, etching designs on glass, embossing thin



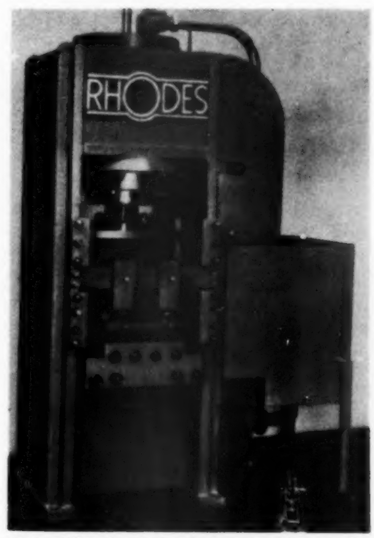
The casing of the Burgess Vibro-Tool is moulded by the Mechanical Rubber Company Limited using a Cellobond rubber reinforcing resin made by British Resin Products Limited

gauge metals and cutting heavy gauge card templates. The price of the tool, complete with carbide-tipped engraving point, is 75/- or, with a kit of 20 interchangeable accessories, etc., housed in a hinged-lid enamelled metal box £5 17s. 6d.—Burgess Products Company Limited (Small Tools Division), Sapcote, Leicestershire.

Billet Shears

By the use of electro-hydraulic actuation, a new design of billet shear by Joseph Rhodes & Sons Limited, Wakefield, gives complete protection from damage by overloading, and at the same time provides complete safety for the operator. The hydraulic gear is pneumatically controlled, a pressure relief valve in the hydraulic circuit preventing overloading and risk of damage.

Substitution of castings by fabricated steel gives a modern clean design and enables the machines to be built to meet customers' exact specifications. Exceptionally long slideways ensure precise alignment of the ram, and prolonged



Rhodes billet shear with electro-hydraulic actuation

blade life. Though primarily designed as a billet shear, the design is flexible and can be arranged as a hydraulic double-sided press.

The machine illustrated has a stroke of 5 in. and will take 12 in. × 1 in. mild or stainless steel, with a pressure of 150 ton, single or continuous stroking. Dimensions are: height 8 ft 3 in.; front to back 3 ft; left to right 5 ft 6 in.; weight 5 ton. The blades have jaw cutting edges.

technique

—devoted to the discussion of practical problems
Readers are invited to contribute items from their own experience in matters relating to design, manufacture and maintenance

Factors Affecting the Choice of an Electric Motor

When placing an order for an electric motor it is very important to give the manufacturer full particulars of the load and method of operation, in order to ensure that the most suitable motor for the work is supplied. For instance, if a continuous steady load has to be dealt with, then a continuously rated motor of the required horse-power output will be supplied. In many cases, however, the load is intermittent, and the power required to drive it may vary widely over short periods of time, as for example in the case of cranes and other types of lifting machinery. For such loads it is usual to employ short-time rated motors, i.e. motors which are designed to carry their full rated load continuously for a specified limited period of time only, with unloaded periods alternating with the loaded periods.

There is a method of determining the required horse-power output of a motor to drive a load of intermittent character, where there is a definite cycle of operations. Take a case where there is a steady load of 60 hp sustained for a period of 40 sec, followed by an idle period of 50 sec to complete the cycle, which is then repeated throughout a period of 6 hr. The horse-power of the required motor would then be:

$$\text{load} \times \sqrt{\frac{\text{time on}}{\text{time on} + \text{time off}}}$$

$$= 60 \times \sqrt{40/(40+50)}$$

$$= 60 \times \sqrt{40/90} = 40 \text{ hp}$$

Take now the case where the load is both intermittent and varying in character. A typical cycle of operations might be as follows:

30 hp required for a period of 10 sec
50 hp required for a period of 15 sec
An idle period of 10 sec
20 hp required for a period of 5 sec
Total period of cycle .... 40 sec
Cycle to be repeated for 4 hr.

Then the required horse-power of the driving motor would be:

$$\sqrt{30^2 \times 10 + 50^2 \times 15 + 20^2 \times 5 \div 40}$$

$$= 34{\cdot}8 \text{ hp}$$

A 35 hp motor is therefore required.

Another important factor affecting the choice of an electric motor for a particular duty is the question of starting conditions. Where a motor has to be started against a connected load it is advisable for the purchaser to obtain from the manufacturer a guarantee that the motor offered will develop sufficient starting torque to run up to speed under the specified starting conditions.

The actual torque required to start the driven machine can usually be found by wrapping a cord around the half-coupling or pulley and measuring the pull required to start the shaft rotating. If the pull, recorded on a spring balance, is denoted by P lb, and the radius of the pulley (or coupling) is R ft, then the required starting torque is $P \times R$ lb ft.

The starting torque of a motor, which can be measured in a similar manner, depends upon the type of motor and starter used. A three-phase, squirrel-cage motor will usually exert about 1½ times full load torque when started direct-on-line. With star-delta starting, the starting torque is only about half full load torque.

The running torque of a motor at full load = hp × 5250 lb ft ÷ rpm

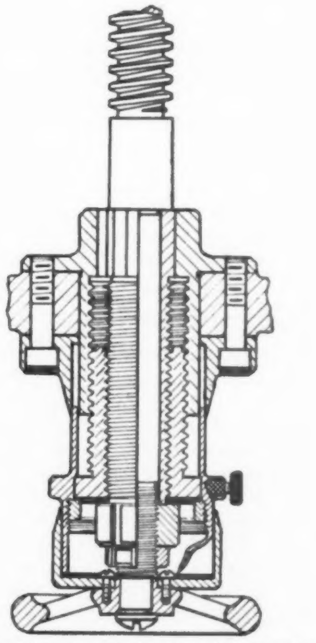
From the foregoing it will be appreciated that when ordering an electric motor, the manufacturer should be given full details of the load and starting conditions. In this connection, it is important to ascertain from the local Electricity Supply Authority whether there is any regulation limiting the starting current, which might prevent the use of a direct-on-line starter with motors above a specified horse-power.

STARTING TORQUES AND CURRENTS (PER CENT OF FULL LOAD)

Class of Starter	Starting Torque		Starting Current	
	Normal-torque Motor	High-torque Motor	Normal-torque Motor	High-torque Motor
Direct-on-line	100	200	450–600	550
Star-delta	33	66	150–200	180
Auto-transformer				
50% tapping	25	50	120–150	140
60% tapping	36	72	160–220	200
80% tapping	64	128	300–400	350

Differential Screw Fine Feed Mechanism

A device for giving a fine movement to a machine table after it has been brought into position as accurately as the directly operating handwheel will allow, is shown in the accompanying sketch. The lead screw is carried right through to the handwheel which is rigidly attached in the usual manner. Surrounding the lead screw and within the external housing is a bush with internal and external screw threads of different pitch. To bring the differential mechanism into action the knurled screw seen on the right is used to clamp the knurled hand ring through which it passes to the screwed differential bush. While the handwheel is held steady the knurled ring is then rotated, causing the screwed bush to rotate and advance the lead screw (via an inner keyed or splined bush in which the lead screw rotates between collars) a small amount determined by the difference in pitch between the inner and outer screw threads. The device is the subject of British Patent 881, 357.

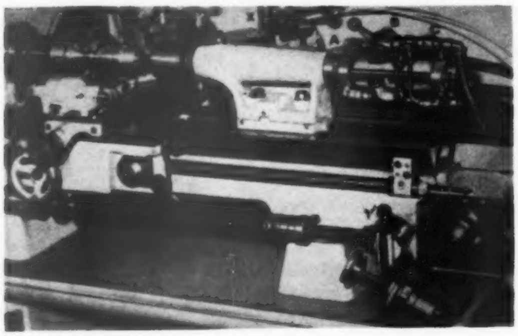


Differential screw mechanism as applied to machine table

Air Controls for Hydraulic Copying Lathe

An interesting application of air controls to a hydraulic copying lathe has been devised by Mr. S. Ash of Ash Metal Products, who, to overcome the variable pressure exerted by hand adjustment, has replaced the conventional tail stock handwheel by a Schrader double-acting cushioned air cylinder. The piston rod of cylinder A (see photo) is connected to the tail stock barrel, which has a built-in revolving centre. When valve B is operated, the piston extends at a fixed speed, which is regulated by flow control valve D. The piston exerts a constant pressure which, when applied to the work-piece, engages the work driver and the work-piece rotates. As a safety measure a non-return valve C has been fitted to ensure trouble-free operation even in the remote event of an air failure.

The copy slide control lever X^1 advances the copy slide into the work position and hydraulic traverse lever Y^1 is engaged. To obviate the possibility of damage resulting from the engagement of the traverse fast return whilst the stylus is on the copying master, another safety device has been incorporated. As the copy slide control lever is moved forward it actuates the mechanical lever of Midget disc valve X. This valve directly controls the Midget cylinder Y and causes the piston with, its attachment, to react, making it impossible to move the traverse lever Y^1 into rapid reverse until a later stage in the operation.



Application of Schrader controls to hydraulic copying lathe

Constant inlet pressure is necessary for the cylinder to exert a constant piston pressure. This is achieved by fitting a Schrader air pressure regulator in the line.

The pneumatic set-up employed for the substitution of the tail stock handwheel has also been successfully used for the high speed drilling of blind holes in brass.

Remote Monitoring of Electrical Strain Gauges and Thermometers

A selector switching system has been designed at the National Coal Board Mining Research Establishment which enables any one of over 1000 remotely situated measuring points to be connected to a common set of four lines feeding appropriate measuring equipment at the selector station.

The system has been installed at a colliery in the West Midlands Division of the National Coal Board to facilitate a programme of measurements on the behaviour of two newly sunk shafts. Electrical gauges to measure strain and temperature were embedded in and behind the concrete linings in groups at strategic positions as the shafts were sunk. Measurements on these gauges are intended to be made for at least a decade.

The selector system employs a number of slave units located in the shaft near each set of gauge positions. On instructions from the surface control station an electric motor in the appropriate slave unit drives a rotary switch to connect the required measuring point to the measuring lines. As the switch moves, pulses are fed back to the control station and are used to indicate the position of the slave switch. Connection of the measuring equipment can only be completed after the indicated and actual positions of the slave have been automatically compared and found correct.

Since access to the gauge positions and slave units after installation is extremely difficult, means have been provided at the surface station for checking the performance of the slave units and for assessing the condition of the electric switch motor. It is hoped that once the installation has been completed no further access to the shaft will be required.

Computing Steam Tables

A method of using an electrical digital computer in the preparation of new steam tables has been developed successfully at NEL. This enables tables of the principal physical properties of steam to be prepared more quickly and accurately than in the past.

As a result of growing industrial interest in the use of steam at higher temperatures and pressures, it has been agreed internationally that draft tables should be prepared covering temperatures up to 800° C and pressures up to 1000 atmospheres.

The basis of the method is to derive an empirical equation of state from all available experimental data on pressure, volume and temperature properties. This involves the use of the computer to fit a surface to about 1000 experimental points. The equation of state derived at the Laboratory fits the experimental data very well in the pressure range zero to 1000 atmospheres at temperatures from 200° C upwards.

A great advantage of this method is that all the required properties can be derived from the equation by straightforward mathematical processes. This leads to consistent tables, and so is preferable to graphical methods or combined graphical and numerical methods.

A set of values of specific volume has been calculated from the equation and compared with two sets produced recently in other countries; further work is in progress to produce tables of specific enthalpy and specific heats.

Further information is given in: *NEL Report* No. 7 (An equation of state for steam, by R. W. Bain, Miss E. A. S. Paton and Miss A. S. Scrimgeour) available from the National Engineering Laboratory, East Kilbride, Glasgow.

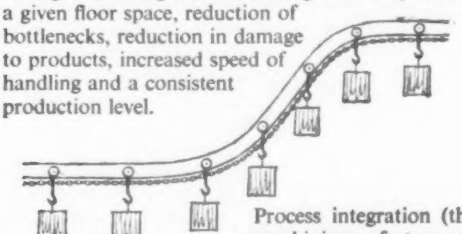
CUT HERE

Materials Handling-1

Materials handling may well be defined as the technology covering the movement and storage of everything in and about industrial or commercial premises. The term covers the handling of raw materials as well as tools; the movement of components between operations and in stores, of finished products, and of the scrap, cutting oils and process machinery; and the movement of workpeople in relation to the handling of material.

The object of a materials-handling survey is to eliminate handling as far as possible and to study the remaining operations to ascertain if they can be economically and efficiently mechanised, i.e., if mechanical handling can be applied.

Improved materials handling raises productivity, for it gives, among other benefits: greater output from a given floor space, reduction of bottlenecks, reduction in damage to products, increased speed of handling and a consistent production level.



Process integration (the combining of two or more processes in one situation or machine with no manual inter-process handling, or the mechanical linking together of two or more processes for automatic operation) is one of the preliminary steps in the development of automation. A stage is achieved quite close to automation when the processing and handling are completely integrated, for then instrumentation and control can be readily applied.

MECHANICAL HANDLING

Many kinds of mechanical-handling equipment are in use today, each with its own attributes and uses, but in most cases there is only one type which offers the best solution to any one handling problem. Most mechanical-handling equipment is electrically operated, and the judicious use of electricity in this way can substantially increase productivity, reduce production costs and improve conditions for the worker, for the expenditure of very little power.

Main Categories of Mechanical Handling Equipment

LIFTING EQUIPMENT; OVERHEAD RUNWAYS; CRANES; CONVEYORS AND ELEVATORS; INDUSTRIAL TRUCKS.

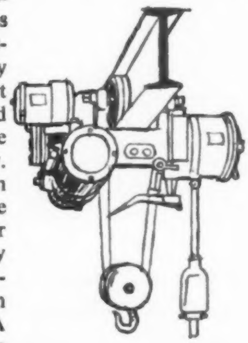
LIFTING EQUIPMENT

Electric pulley blocks are used for loading and unloading purposes, warehousing and in process work. When used with a trolley they have great flexibility. No manual effort is required, hence lifting does not cause any fatigue. They may use either chain or wire rope, and the speed of lift of both types is slower as the lifting capacity increases. An inching motor may be fitted to give a very slow speed for accurately positioning the load, for example in a jig.

Lifting magnets are used for the handling of iron and steel in conjunction with a crane or hoist. They do away with the necessity for slings and give increased speed of movement. They can lift castings, ingots and swarf, scrap, rolled steel sections, and can be used in loading bays, yards, machine shops, foundries and steelworks.

OVERHEAD RUNWAYS

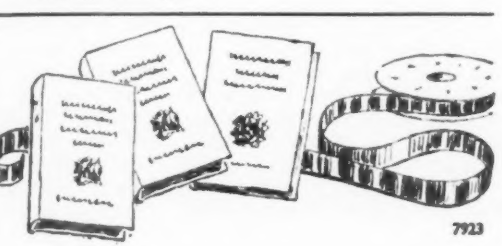
Overhead runways have many uses where lifting and/or transport are required, when frequency of flow does not warrant a conveyor, e.g., for loading and unloading lorries, in core ovens, for feeding machines, for storage, for maintenance purposes, for textile drying and interconnecting two or more buildings. A runway consists of a steel girder along which a load trolley runs, and can incorporate switches, turntables, drop-sections and drop-arms and weigh-sections. Electrification of a runway takes all the manual effort out of the handling and movement, which can be completed more quickly. It consists of two main items: the electrified drive of the trolley (i.e., a power trolley) along the runway and an electrically operated lifting unit, usually an electric pulley block. A telpher has a cab for the operator suspended from trolleys on the runway and mechanically connected to the electrically driven trolley of the pulley blocks, thus travelling with them. Telphers are employed for handling individual loads which may be outside the range of normal electric blocks, e.g., when the highest speeds of travel or hoisting are required.



For further information, get in touch with your Electricity Board or write direct to the Electrical Development Association, 2 Savoy Hill, London, W.C.2. Telephone: TEMple Bar 9434.

Excellent reference books are available on electricity and productivity (8/6 each, or 9/- post free)—'Materials Handling in Industry' is an example.

E.D.A. also have available on free loan in the United Kingdom a series of films on the industrial uses of electricity including one on materials handling. Ask for a catalogue.



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Surface Speed Indicator

In the process of making newsprint wet pulp is introduced at one end of the paper making machine and the bulk of the water having been allowed to drop through an endless belt of wire mesh, the fibres are brought together in the form of a web, which is then fed through a series of rolls, some hot, some cold, according to their particular job. To offset shrinkage and maintain an even tension, the rolls, which are of different circumferences, are designed to run at different speeds, each successive section running a little faster than the last. It is of primary importance that the difference of roll speed be known with a high degree of accuracy.

At the Mersey Mill of Bowaters United Kingdom Pulp & Paper Mills Limited, at Ellesmere Port, Electronic Machine Company Limited, Mayday Road, Thornton Heath, Surrey, in conjunction with Bowater engineers have designed and installed an electronic speed indicator which will give an instant reading on any pair of rolls. This is an electronic tachometer which has been modified to give a surface speed reading and in order to meet the very rigid requirements of the paper web control, a very rapid series of readings has had to be arranged.

For example, if a man with a stop-watch and a chalk mark counts at the rate of 1 rpm, the equipment is so designed that it counts, in effect, 30 chalk marks per minute or 1 chalk mark every 2 seconds, thus, the speed, i.e. 1 rpm, can be obtained in 2 sec. If the circumference is 1 ft then the equipment would display a surface speed of 1 fpm, if the circumference is 2 ft, then for the same surface speed, the roll would be rotating at $\frac{1}{2}$ rpm and the count must be 4 sec, twice as long, to display the same surface speed, i.e. 1 fpm. Thus by varying the counting time different roll diameters can be taken into account.

The main unit is so arranged that it can be switched to give a reading on any pair of rolls, and a system of switching has been incorporated whereby the correction for different circumferences is automatically adjusted on switch over. It is of interest that correction for varying circumferences is pre-set and can be altered as necessary should any change in the rolls take place. Accuracy in this particular case was required to the order of + 0 and − 1 ft per min, but a greater degree of accuracy may be obtained if required.

POWER REGULATOR.—One of a range of Trinistor a.c. power regulators now available as free standing units or as sub-assemblies for inclusion in an existing control panel. They are highly efficient over the complete range of control and all components are hermetically sealed and suitable for 45° C ambient temperature operation. Westinghouse Brake & Signal Company Limited, 82 York Way, Kings Cross, London N1.

New 4 in. Univac Pump

A new 4 in. self-priming, unchokeable centrifugal pump, known as the Univac UVS4 has been introduced by Henry Sykes Limited of 53b, Southwark Street, London, SE1. Salient characteristics include a self-priming time of 13 sec at 10 ft suction, an output of 27,900 gph at this lift with nominal head and an ability to pass solids of up to $2\frac{1}{2}$ in. dia in addition to free flowing slurries and abrasive sludges of up to 60% solids content. At 28 ft vertical suction lift, the priming time is 58 sec and the output is 7200 gph. The UVS4 is close coupled to a Lister SL3 air cooled 3 cylinder diesel engine which develops 10·8 bhp at 1500 rpm and 12·75 bhp at 1800 rpm. The close coupling shaft between the engine and the centrifugal pump is fitted with a renewable hardened sleeve where it passes through the flexibly mounted pump packing gland. This gland is externally sealed by grease impregnated packing and may be repacked at any time without dismantling the pump. The three bladed impeller is of impact and wear resistant nodular cast iron, whilst the wearing plates and casing are of high grade grey cast iron, thus eliminating the possibility of electrolytic action arising and enabling sea water to be pumped without deterioration. Where liquids which corrode cast iron are to be handled, the pump components are supplied in suitable material.

3-Ton Hydraulic Mobile Crane

A new 3-ton hydraulically operated mobile crane, based on the Fordson Super Major tractor unit, is announced by Tunny Cranes Limited, Abbey House, Victoria Street, London SW1. Fitted with a 16 ft jib, this crane is designed to lift 3 ton at 7 ft radius, giving a height of lift of 17 ft under the hook from 4 ft above ground; 2 ton at 9 ft, and 1 ton at 14 ft 9 in. A 10 ft extension is available and when fitted the lifting capacity is rated at $1\frac{1}{4}$ ton at 8 ft to 10 cwt at 20 ft radius. The maximum hoisting speed is 60 fpm. The Fordson Super Major 4-cylinder diesel engine which powers this crane, develops 51·8 bhp at 1800 rpm. Hydraulic power to operate the hoisting, derricking and slewing motions is provided by a Vickers vane type pump, driven off the engine crankshaft through a flexible coupling. This pump maintains a system pressure of 1550 to 1650 psi and has a rated capacity of 8 gpm at 1500 rpm, requiring 12-14 hp to drive.

The pump delivers to a control circuit through a relief valve which gives maximum circuit pressure and prevents overloading of the pump and system. Manually operated directional valves are mounted in a bank for movement selection and speed control. The cylinders are double acting, with hard chromium-plated rods and wiper seals. Fluid is carried to the cylinders by Aeroquip flexible hose fitted with reusable couplings. Hydraulic locks are provided in the hoist and derrick cylinders so that in the event of power failure the pressure is maintained and the load held in position until released by an overriding manual control.

Communication System

A new simple and self-contained portable microphone/amplifier/loudspeaker is being marketed by AEI Electronic Apparatus Division. It is only necessary to connect two of the units together by any length of standard workshop flex or cable to have available a two-point, two-way, loudspeaking communication system. No mains supply is required.

Edgar Allen's of Sheffield . . . ,
I thought they only made
steel castings

ENGINEERS' TOOLS · TOOL STEELS · RAILWAY & TRAMWAY TRACKWORK
PERMANENT MAGNETS · STEEL CASTINGS · CEMENT PLANT · CRUSHING
GRINDING & DRYING MACHINERY · DUST COLLECTION PLANT

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P6

In Brief . . . .

Notes on New Materials, Plant and Machinery

Continuous Casting.—The first production basis combination of a converter and a continuous casting machine is in service at Dillingen in W. Germany. It was designed, made and erected by Schloemann A.G., Dusseldorf, associates of Concast A.G., Zurich, whose other associates are Distington Engineering Company Limited, Workington, and Compagnie des Ateliers et Forge de la Loire, Paris.

Air Jet Balance.—A 6 ft column of water and an air jet are essential elements in a sedimentation balance used by Royal Dutch/Shell Exploration & Production Laboratories in the Netherlands to measure the quantities of granular particles of different sizes formed in sedimentary formations. The speed through the water varies with the size of the particle.

All-Hydraulic Cranes.—The first demonstration in Britain of Metro-Hendre-Cammell all-hydraulic mobile cranes and sideloaders was given on May 1 by Metropolitan-Cammell Carriage and Wagon Company Limited, Birmingham 8. The range (initially five cranes and three sideloaders) rely on hydraulic power for all movements including road traction.

Portable Air Compressor.—The new RP-140 rotary portable air compressor announced by the Air Power Division of Joy Sullivan Limited is the smallest of the "Airvane" series. Output is 140 cfm free air delivered at 120 psi maximum.

Hydraulic Jack.—The S159 Hydra-Toe is the latest Simplex jack made by The Equipment and Engineering Company Limited, London WC2. It has twin cylinders and will lift its full capacity of 15 ton on the toe.

Painting on Zinc.—A new process, "Brush Bonderite-Z" has been developed by The Pyrene Company Limited, Brentford, for brush or spray treatment of zinc and galvanized surfaces prior to painting.

Hour Counters.—Three new counters for measuring the life of components and machine time programmes have been added to the range made by Measuring Instruments (Pullin) Limited, London W3.

High Speed Packaging.—The production of an automatic wrapping, gassing and cartoning machine with an output up to a nominal 120 AFD food packs per minute is planned by Vickers-Armstrongs (Engineers) Limited, London SW1.

Cable Cleaning.—A plant developed by British Vacuum Cleaner & Engineering Company Limited, Leatherhead, in conjunction with National Coal Board engineers, for cleaning rubber sheathed cable, consists of contra-rotating power driven brushes in a dust proof enclosure connected to a portable vacuum cleaner.

Electrical Indicator.—A new numerical indicator for capacitance, resistance or voltage by Nash & Thompson Limited, Tolworth, is a servo-driven potentiometer with digital indication of setting.

Micro Comparator.—An instrument for machine tool operation and comparing dimensions and small movements has been introduced by Ferranti Limited, Edinburgh. It has a stylus on a measuring head connected by flex to an indicator unit.

Fire.—A new 15 lb dry powder extinguisher announced by Nu-Swift International Limited, Elland, is designed to cope with fires from inflammable liquids and live electrical equipment.

Bender for Heating Elements.—The most complicated shapes can be cold formed from Pyrobar heating elements without in any way damaging the element with the aid of the new hand bender marketed at 55/- by Associated Electrical Industries Limited, Manchester.

Pipe Couplings.—The new KP pipe couplings introduced by Keelavite Hydraulics Limited, Coventry, can be used repeatedly without leak or loss of grip.

Organic Acids.—"Versatic 911" is a new synthetic organic monocarboxylic acid made by Shell International Chemical Company. It may be used in resins, paint dryers, fungicides, etc.

Transistor Holders.—Hellerman Limited, Crawley, have a new range of moulded transistor holders for simple and effective mounting.

Latex Dipping Machine.—A small and flexible latex dipping machine for the laboratory has been developed by Lionel Hook & Sons Limited, Stroud.

Film Memory.—An experimental magnetic thin film computer memory which operates at 10^{-8} sec is announced by IBM United Kingdom Limited, London W1.

Timing Unit.—The new "Varicycle" unit of Electrical Remote Control Company Limited, Harlow, controls the switching of an electrical circuit with continuous adjustment of "on" and "off" periods.

Ventilator.—The "Bonaire" is a new device for providing draughtless ventilation in every form of building. Makers are E. D. Hinchliffe & Sons Limited, West Bromwich.

Decimal Counting.—A plug-in three-level ten-outlet miniature uniselector with economic life of 80 million steps has been added to the range made by AEI Telecommunications Division, London SE18.

Blowpipe.—The new double duty Demon blowpipe made by Suffolk Iron Foundry (1920) Limited, Stowmarket is now available in a fitted metal box.

Industrial Adhesive.—For use on metal, wood and plastic, a new adhesive cold filler is a product of Rowan & Boden Limited, Paisley. It sets within one hour and can then be buffed, sawn, drilled or tapped.

Gamma Radiography.—Pantak Limited, Windsor, have extended their range of equipment for the non-destructive testing of metals, castings, welds, etc., by inclusion of Pantatron gamma-ray units.

Control Systems.—A consultancy service for design and evaluation of hydraulic, pneumatic, electric and other controls is offered by Bradbury Controls Limited, Hampton.

Steam Trap Control.—The Gestra Vaposcope marketed by I. V. Pressure Controllers Limited, Isleworth, provides a sight-controlled check on the condensate flow in any steam pipe system.

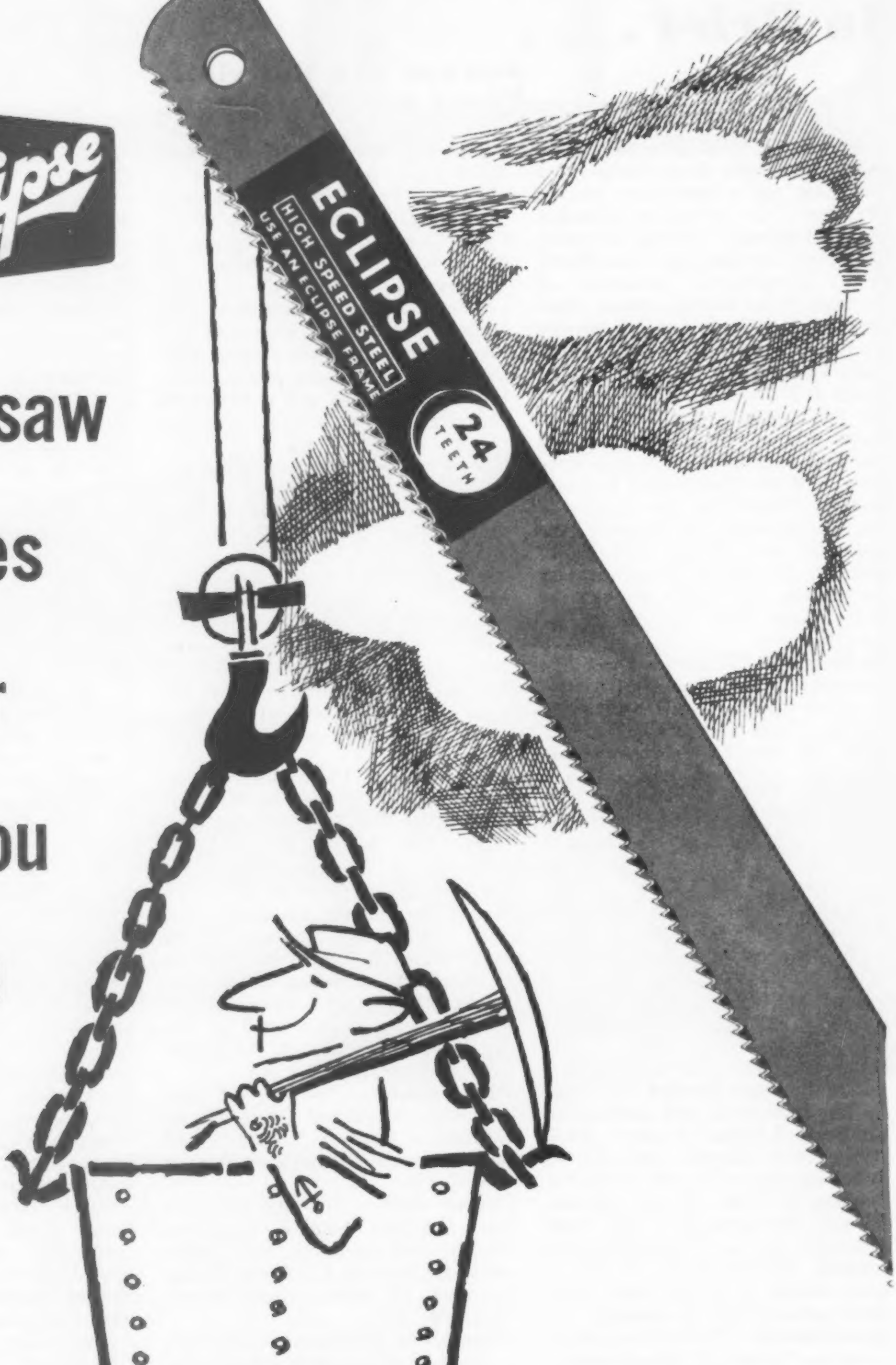
Wrapping Machinery.—A new range of packaging machinery specially designed to use the new shrinkable films has been developed by C. F. Taylor (Unity Designs) Limited in conjunction with Robinson Plastic Films Limited, Bristol.

Shifting Skates.—Skates of 15 to 100 ton capacity for shifting machinery are made by Verrolec Limited, Cricklewood. They embody a chain of track-laying rollers.

Correction.—The output of the machine noted under the title "Mobile Compressor" on this page in our April issue should have read "120 cu ft free air delivered at 100 psi".

Eclipse

hacksaw blades never let you down



'Eclipse' hacksaw blades and other tools are made by James Neill & Co. (Sheffield) Ltd. and are obtainable from all tool distributors.

UH 63

books

Great Engineers. By L. T. C. Rolt. London, 1962; G. Bell & Sons Limited. 18/6 net (by post 19/6). 244 pp. 5 × 7⅞ in.

This book is an addition to Messrs. Bell's series on great men in different fields of endeavour. In writing it Mr. Rolt has not duplicated his earlier biographical work but has usefully added to it by providing shorter biographies of ten further great men. Not all of the names are widely familiar, even among engineers, but they all deserve to be, perhaps more particularly those whose modesty led them to shun the limelight. The ten are: Abraham Darby, ironmaster; Thomas Newcomen, pioneer of steam power; William Jessop, builder of canals and railways; Matthew Murray, pioneer mechanical engineer; Henry Maudslay, master mechanic; John Fowler, pioneer of mechanized agriculture; Benjamin Baker, designer of the Forth Bridge; R. E. Crompton, pioneer electrical engineer; and F. W. Lanchester, innovator in automobiles and aeronautics. Mr. Rolt tells a fascinating story about each. None found the going easy and all had to wrestle with major problems, and each contributed much to the development of engineering practice, and some of them significantly to applied science. Readers of Mr. Rolt's earlier biographies will readily add this further volume to their shelves. To those who have not, it can be confidently recommended as absorbing reading; and it is an excellent introduction to engineering biography for those who may not as yet have encountered this interesting and rewarding aspect of their profession.

Vector Mechanics for Engineers. Part I, Statics. Edited by Harry R. Nara. London, 1962; John Wiley & Sons Limited. 49/- net (by post 50/6). 455 pp. 5¾ × 9 in.

The authors of this book are of the opinion that formal vector methods should be introduced at the commencement of the study of mechanics so that facility in their use will be developed, first for those who eventually go on to advanced work, and secondly so that those who do not, but who are nevertheless constantly faced with the need to keep abreast of developments within their sphere, will have the generalized necessary equipment. This work is therefore a text book of statics (it being Vol. I of a larger treatment) and also a tutorial text in the exclusive use of vector methods. It opens with a concise history of the subject over the past 2500 years and then introduces basic concepts—forces, resultants, etc.—and goes on to equilibrium, work, structures, friction, slender members, and finishes with appendices on vector operations, geometrical properties, and properties of plane geometric figures. Being designed for the purpose the book is invaluable for teaching. It is well supplied with examples, and problems (with answers) for practice which together with the lucid text make it readily acceptable also for private study—a quality, incidentally, which will no doubt attract an older generation who might wish to add the generalized vector method to their analytical equipment.

Modern Transmission Systems. Motor Manuals Vol. 5. By Arthur W. Judge. London, 1962; Chapman & Hall Limited. 25/- net (by post 26/-). 429 pp. 4¾ × 7¼ in.

From the days when the gearbox was no more than the subject of one chapter in a book on motor cars, we have today this whole volume devoted to these essential but various mechanisms. There is, of course, still the manually operated gearbox in its modern form, and there is the overdrive unit and free wheel or over-running clutch, and there is also the epicyclic box and the automatic clutch as well as the torque converter. These are well established but have their modern forms. The newer transmissions are the semi-and fully-automatic systems, the dynaflow and triple turbine, the hydra-matic and there are still others, all of which may be understood from the descriptions and illustrations given in this book, which is the latest addition to Mr. Judge's series of motor manuals. There is no need to describe or commend the style of the book—the author is too well known in automotive literature for that to be necessary. Suffice it to say that as a companion volume it matches well with the others in the series and will doubtless be as well received.

English-Polish Technical Dictionary. Edited by S. Czerni and M. Skrzynska. London, 1962; Pergamon Press Limited. £3 net (by post £3 1s. 1d.). 443 pp. 5⅝ × 8 in.

The collection of English words in this dictionary seems to be well chosen for modern needs. The sciences and technologies covered have evidently been catered for by reference to modern texts, thus we find the terms of rocketry and nucleonics as well as the much longer established names of tools and machines, a variety which is similarly perceptible in the terms relating to other sciences and technologies. There are some 34,000 terms with their Polish equivalents.

General Industrial Science. By Ernest H. Wise. London, 1962; Blackie & Son Limited. 25/- net paperback (by post 26/-). (Board edition 40/- net). 454 pp. 5⅜ × 8½ in.

Students taking many of the technological examinations find that for part of their course they have to know something, though not a lot, about several subjects. In this book the requisite knowledge has been collated and condensed to cater for the requirements of a wide range of syllabuses, much of the text, indeed, is more like a handbook of fundamentals than a typical tutorial text, and probably all the better for it. The subjects covered are industrial chemistry; heat, light and sound; mechanics of solids and liquids; instrumentation; technical electricity; chemical engineering operations, engineering materials; and an introduction to engineering drawing and safe working practice.

Mechanical Handling Directory.—This new directory has five main sections. They are a classified guide to equipment containing over 8500 entries, a language glossary for French, German and Spanish speaking users, specifications and descriptions of equipment, proprietory names, and names and addresses. The directory is published for "Mechanical Handling" by Iliffe Books Limited, price 40/- net (by post 42/3).

For the convenience of readers—

Books mentioned on these pages may be ordered by post through MECHANICAL WORLD Offices. Please state author, title, publisher and price by post when ordering.
Mechanical World Offices: 31 King Street West, Manchester 3.
158 Temple Chambers, Temple Avenue, London, E.C.4

BOOKS

Oil and Gas Engine Working Costs.—The Diesel Engine Users Association (18 London Street, London EC3), has issued its report on working costs for 1961. The report has been restyled, has an index, and the first table not only gives engine particulars but includes other relevant data such as class of fuel used, hours run and details of lubrication. There are 460 engines covered by the report. Undertakings are now classified according to whether the plant is primarily a source of power or is for peak load and/or emergency service. Lubricating oil consumption figures have been reinstated in the tables.

Machinery's Buyers' Guide.—The 1962 edition of this directory of suppliers of machine tools, small tools, metals, materials and plant for the machine shop is now available price 12/6 (by post 15/-) from Machinery Publishing Company Limited, 21 West Street, Brighton 1. More than 5000 suppliers and their products are listed.

NRDC Bulletin.—The April (No. 20) issue of the Bulletin of the National Research Development Corporation, (1 Tilney Street, London W1,) describes a general purpose X-ray powder camera developed by the University of Aberdeen. Descriptions are given of inventions available under licence.

Mechanical Handling.—A directory has been issued by the Mechanical Handling Engineer's Association (94/98 Petty France, Westminster SW1), which gives information on the activities of the association, describes the scope of the industry and includes a list of members.

Engineering Associations.—The organization for Economic Co-operation and Development 2 Rue André-Pascal, Paris 16, has published a second edition of its extensive list of international associations connected with the engineering industries. The bodies listed differ widely and their interests range from trade to scientific matters. The text is in both French and English.

Industrial Disputes.—A new booklet from the Institute of Industrial Supervisors (24 Albert Street, Birmingham 4, price 3/6) brings together three widely separated view-points on "Management Responsibilities and the Avoidance of Industrial Disputes", from a trade union leader, an industrialist and ("the man in the middle") a supervisor who takes both the others firmly to task.

Safety in Melting and Founding.—Requirements for the safety, health and welfare of persons employed in the melting or founding of non-ferrous metals are proposed in The Draft Non-ferrous Metals (Melting and Founding) Regulations, 1962 (H.M. Stationery Office price 8d. net), issued by the Ministry of Labour. The regulations cover not only processes in non-ferrous foundries, but also certain processes in the bulk non-ferrous metal industry, namely melting, casting and stripping.

Visual Appearance.—An extension of the three-attribute system of colour description is presented in a paper entitled "A Five-attribute System of Describing Visual Appearance" (STP 297) published by the American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pennsylvania, U.S.A., price $1.00 The purpose of the system is to describe adequately metallic surfaces and the appearance of engineering materials generally.

B.E.A. Handbook 1962.—This thirty-third annual edition is a stoutly bound quarto size volume of 576 pages and includes a comprehensive list of engineering products and their manufacturers, classified under more than 3,000 headings in English, French, German, Portuguese and Spanish. It may be obtained, price 30/-, post free by surface mail, from the British Engineers' Association, 32 Victoria Street, London SW1, England.

New Standards

Light-current semiconductor devices (B.S. 3494: Part 1: 1962). Price 6/-.

This memorandum lists the ratings, characteristics and other parameters of light-current semiconductor devices which are regarded as the minimum data that should be quoted by the manufacturer when describing his product for general sale. Part 2, now nearing completion, will deal primarily with methods of measuring the characteristics listed in Part 1. To facilitate the comparison of devices offered by different manufacturers it is necessary that the data sheets describing performance should contain, as a minimum, information on essential ratings and characteristics, quoted in the same terms by all manufacturers; adoption of the recommendations given in Part 1 will assist in achieving this. Part 1 does not specify the numerical values of ratings and characteristics. Devices primarily intended for use in industrial power equipment are not included in the memorandum. Similar information relating to power diodes, which are not covered by the memorandum, will be published separately.

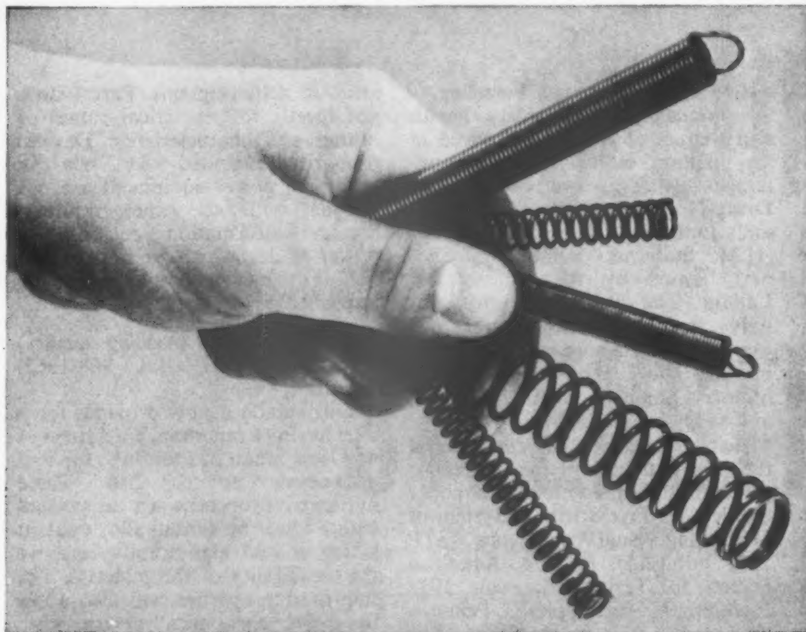
High yield stress (welding quality) structural steel (B.S. 968:1962) price 4/-

This standard now provides for a steel having a minimum yield stress of not less than 22 ton/in² for all thicknesses up to 2 in. These improved properties are associated with a lower maximum alloy content which should significantly improve the weldability of the material. The improved properties will also allow for more economical design when based on criteria such as B.S. 153, 'Steel girder bridges' and B.S. 449, 'The use of structural steel in buildings.'

British Standards Institution, 2 Park Street, London W1.

ASTM Standards.—The 11-volume 1961 *Book of ASTM Standards* contains over 17,000 pages and 3,000 standard specifications, methods of test, definitions of terms, and recommended practices. The increase from 10 to 11 parts in 1961 was necessitated by a growth in size of the volume on plastics, carbon black, rubber, and electrical insulation to the point where it could no longer be bound economically and was becoming unwieldy in size. Information covering these subjects is now contained in two volumes. Each part contains a detailed index, a table of contents and a numerical list of standards. A combined index to all ASTM standards is furnished without charge to purchasers of two or more volumes. The complete set is priced $195:00 from the American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pennsylvania, U.S.A.

Translations of German Standards.—The German Standards Committee (Deutscher Normenausschuß), Berlin W15, has established a special department to prepare translations of German industrial standards in English. So far, 1200 English translations have been made. New lists of the translations available may be obtained free of charge from the Beuth-Vertrieb GmbH, Berlin W15, Uhlandstr. 175.



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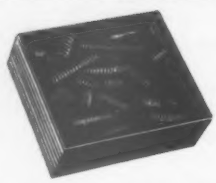

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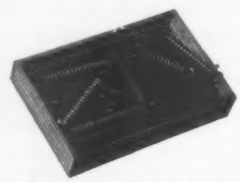
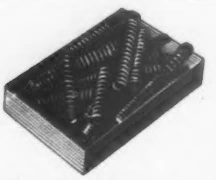
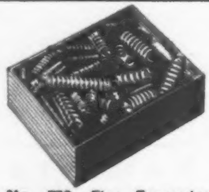


No. 753. Three dozen Assorted Light Expansion ¼" to ½" diam., 2" to 6" long, 22 to 18 S.W.G. **12/-**



No. 760. Three dozen Assorted Light Compression Springs. 1" to 4" long 22 to 18 S.W.G., ¼" to ½" diam. **7/6**

No. 1217. One gross Assorted springs. **45/-**



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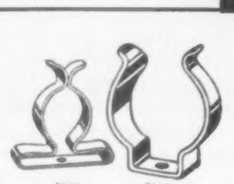

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HT83

BUSINESS & PROFESSIONAL

Personal

Mr. Martin H. L. Whitehouse, M.A., B.Sc.(Econ), A.M.I.Mech.E., A.M.I.E.E., has been appointed secretary of the British Engineers' Association.

ASSOCIATED ELECTRICAL INDUSTRIES Limited, *Transformer Division:* announce the appointment of **Mr. E. R. Hartill, B.Sc., (Eng.) Hons. Lond., M.I.E.E.,** chief engineer, Development; **Mr. G. N. Leech, B.Sc., A.M.I.E.E.,** chief engineer, Power Transformers; and **Mr. M. A. Gudgeon** assistant chief engineer, Power Transformers (Rugby). *Turbine-Generator Division:* **Mr. E. Oakley** has been appointed chief engineer, Technical Commissioning and Servicing Department.

Mr. Noel Holmes has been appointed chief engineer of the British General Electric Company (Pty.) Limited for the Republic of South Africa in succession to Mr. C. Myring who has recently retired.

THE GENERAL ELECTRIC COMPANY LIMITED announces the formation of separate trading divisions each under a divisional manager responsible to the general manager **Mr. T. H. Kelsey,** The divisions and their managers are: Light Engineering Division **(Mr. Ivor James)**; Large Rotating Plant Division **(Mr. F. C. Krause)**; Switchgear Division **(Mr. J. S. Cliff)**; Transformer Division **(Mr. F. J. Fisher)**; Rectifier and Control Engineering Division **(Mr. E. Gallizia)**; Traction Division **(Mr. P. R. Armitage).**

TECALEMIT LIMITED, the holding company announce that **Mr. J. E. Drinkwater** is to be managing director of the wholly owned subsidiary company, Tecalemit (Engineering) Limited, in succession to Mr. P. R. Scutt as from August 1, 1962.

Dr. J. H. Chesters has been appointed deputy director of research of The United Steel Companies Limited.

Mr. N. A. Slater has been appointed a director of Whitehouse Industries Limited, Pontefract—a subsidiary of Pollard Ball & Roller Bearing Company Limited specialising in the manufacture of Philidas self-locking nuts, bolts and setscrews.

Mr. E. Bernard Banks has been elected a director of The English Electric Company Limited and appointed deputy managing director.

R. B. PULLIN & CO. LIMITED announce the appointment of **Dr. R. H. Barker, B.Sc., Ph.D., M.I.E.E.** to the board as technical director.

Mr. Paul R. Cavanagh has been appointed technical sales manager of Experitron, the recently formed development and prototype engineering firm of 165 Young Street, Sheffield 1.

MORTIMER MACHINE TOOL COMPANY Limited and Mortimer Engineering Company Limited announce that the following personnel have been appointed to the board of both companies, **Mr. G. W. Mills** (Managing Director); **Mr. L. W. Moritz, F.C.A., Mr. C. W. Reester** and **Mr. J. R. Tomkins.**

Mr. P. O. de Gale has joined Elcontrol Limited, Wilbury Way, Hitchin, Herts, manufacturers of electronic and automation equipment, as commercial manager.

Mr. Peter Wood has been appointed sales office manager of Singlehurst Engineering Limited, specialists in industrial hose and high pressure pipes and fittings, 72-76 Clun Street, Sheffield.

Mr. L. F. Everard, managing director and **Mr. J. G. Smith,** sales director of H. Leverton & Co. Limited, have transferred their headquarters from the company's premises at Leeds to offices in Maidenhead Road, Windsor. Other departments also moving to this address are those of the used equipment manager, sales control and earthmoving.

Mr. W. D. Pugh, managing director of English Steel Corporation Limited, has been appointed a member of the board of Vickers Limited.

Mr. Stanley W. Hoskins, A.M.I.Mech.E., M.I.P.E., Assoc.R.I.N.A., has retired from the board of I. V. Pressure Controllers Limited, a company which he formed in 1951. His services as consultant will be retained. **Mr. John Armour Smith, Assoc. M.Inst.B.E., M.Inst.M.S.M.,** has been appointed to the board as sales director. The company's sales force in the United Kingdom will now be controlled by **Wing-Commander T. B. Jones, O.B.E., A.F.R.Ae.S., A.Inst.M.S.M.**

Obituary

WE regret to record the death of **Mr. James Whitehead,** joint deputy managing director of The David Brown Corporation Limited.

WE regret to record the death of **Mr. Gilbert Henry Jolley.** Mr. Jolley retired only a month ago from his position as a director of Associated Electrical Industries Export Limited. Mr. Jolley joined Metropolitan-Vickers as a vacation apprentice in 1919.

WE regret to record the death of **Mr. William Spoor, A.M.I.Mech.E., A.M.I. Loco.E.,** divisional executive engineer of F. Perkins Limited.

Addresses

THE ENGINEERING & BUILDING CENTRE has moved to its new premises at Broad Street, Birmingham 1. Telephone: MIDland 1914.

THE telephone number of Livingston Laboratories Limited, 31 Camden Road, London NW1, has been changed from GULliver 8501 to GULliver 4191 (20 lines).

THE NOTTINGHAM OFFICE of the Export Credits Guarantee Department has moved to Equitable House, Old Market Square, Nottingham; the telephone number remains unchanged—Nottingham 46585, and the office is now also available through the telex service—number 37566.

FRANK WIGGLESWORTH & CO. LIMITED, Shipley, Yorkshire, power transmission engineers, have transferred existing and new machinery including automatics into an extensive addition to the machine shop. Coincident with this extensive rebuilding at their head office and works, the company have taken more extensive premises for their branch offices in London and Birmingham, giving greatly improved facilities for customers in these areas.

WOLF ELECTRIC TOOLS LIMITED, London W5, have opened a service branch at 131, Arkwright Street, Nottingham. Telephone: Nottingham 85087/8.

THE Sheffield branch office of Martonair Limited, pneumatic engineers of Parkshot, Richmond, Surrey, moved to larger premises at 4 Sharrow Mount, Psalter Lane, Sheffield 11, on April 9th. The new telephone number is Sheffield 62812.

THE FERODO district office and service depot in Southampton has moved from Commercial Road, where it has been for the past twelve years, to new premises in West Quay Road.

THE LAPOINTE PRECISION ENGINEERING Company Limited is the new name of Lennie & Thorn Limited. The registered office is at Otterspool, Watford By Pass, Watford, Herts., and the works at Western Road, Bracknell, Berks.

THE Midlands office of Acheson Colloids Limited has been moved from Moseley to more convenient new premises in the centre of Birmingham. The new address is Acheson Colloids Limited, St. Martin's House, Bull Ring, Birmingham 5. Telephone: Midland 1559.

A NEW London showroom and demonstration centre, showing the latest conveyor and mechanical handling equipment, has been opened by the Manufacturers Equipment Company of Sutton Road, Hull, at Hallowell Close, Commonside East, Mitcham.

THE names of the manufacturing works of B. Elliott (Machinery) Limited as from April 1, have been changed as under: Victoria Machine Tool Company Limited will be known as Elliott Machine Tool Company Limited and Cardiff Lathe & Tool Works Limited will be known as Elliott Lathes Limited.

Contracts and Work in Progress

EIMCO (GREAT BRITAIN) LIMITED of Gateshead.—Two contracts worth £100,000 for filtration equipment for Poland. The equipment is to be installed in coal treatment plants at Katowice in Silesia.

J. & E. HALL LIMITED, Dartford, Kent. Lift and Escalator Division.—Contract for the lift installation in the Paternoster Development, Paternoster Row, London EC1.

GENERAL ELECTRIC COMPANY (Engineering) Limited.—Order worth over £87,000 for five large induction motors to drive booster pumps and starting and standby boiler feed pumps in the C.E.G.B. West Thurrock Power Station.

WILD BARFIELD LIMITED.—Repeat order for vacuum furnace for C.E.G.B.

Order from John Fellows Limited of Bilston, Staffs, for two large shaker hearth furnaces and ancillary equipment.

EFCO FURNACES LIMITED.—Order from Poland to supply two multi-purpose closed-quench furnaces together with endothermic atmosphere generators, a dewpoint meter, work carriers and Quenzine quench oil.

Order from I.C.I. Metals Division for an 800 kW continuous roller hearth furnace to be used for the inter-annealing of brass strip in coil form.

VICKERS-ARMSTRONGS (ENGINEERS) Limited.—Order from a Belgian shipyard for the supply of a transverse propulsion unit. These are sideways manoeuvring units to ease docking and berthing by instantaneous direct control from the bridge.

Societe Anonyme Cockerill-Ougree of Hoboken are installing a Vickers unit to develop 5 tons thrust in a vehicular ferry for Mediterranean services.

STRACHAN AND HENSHAW LIMITED, Ashton Works, Bristol.—Further order for equipment for the new 560 MW C.E.G.B. station to be built at Oldbury-on-Severn.

CONSOLIDATED PNEUMATIC TOOL Co. Ltd.—Order for 1000 rotary drills from China.

THE POWER-GAS CORPORATION LIMITED, (Davy-Ashmore Group).—Order from Imperial Chemical Industries Limited for synthesis gas plant replacement at their Billingham Works. Contracts valued between £1m and £1½m awarded by Fertilisers & Chemicals Travancore Limited, an important chemical fertiliser producing factory in India. The contracts cover major extensions to the Alwaye, Kerala (Travancore) factory.

THE NEWMAN HENDER GROUP of companies. Supply of all the major industrial valves for a new straw pulp mill now being built at Duna in Hungary. Order placed by Lyddon & Co. Limited, of the Parsons, Whittemore, Lyddon organisation. Newman Hender are also supplying, through Lyddon, valves for a new, 160 ton-per-day, Kraft pulp and paper mill at Suceava, Rumania, which is due for completion towards the end of 1962.

SPIRAL TUBE & COMPONENTS CO. LIMITED. Order valued at £10,000 for oil and water coolers for Saudi Arabia.

ASSOCIATED ELECTRICAL INDUSTRIES Limited.—Contract for the supply of 100 MW turbine-generator, for the new power station to be built on the coast of Nova Scotia, at Tufts Cove, Halifax Country. Order from the North of Scotland Hydro-Electric Board for generating plant to be installed at the new Carolina Port thermal power station, near Dundee. Orders for special high-voltage ignitrons from CERN, Geneva. The valves will be used as part of the "particle extraction" equipment in the Proton Synchrotron at Geneva. *Transformer Division*. Order valued £200,000 from the Central Electricity Generating Board for a 340 MVA generator transformer, value approximately £200,000 for the West Thurrock Power Station. *Motor and Control Gear Division*. Order through Victor Products (Wallsend) Limited, for 3000 stator and rotor units for building into and driving Victor drilling machines for the Chinese coalfields. Order valued at £650,000 from Steels Engineering Products Limited.

THE LOEWY ENGINEERING COMPANY Limited, (TI Engineering Division company) Contract valued at £2,125,000 for rolling mill equipment for the new £32 m, steelworks being built by The Park Gate Iron & Steel Co. Limited at Rotherham.

YORKSHIRE ENGINE COMPANY LIMITED. (The United Steel Companies Limited.) Order for the supply of the six diesel-electric shunting locomotives to Park Gate Iron and Steel Company Limited, of Rotherham. The order, including certain addditional equipment, is worth well over £100,000.

BRIGHTSIDE HEATING & ENGINEERING CO. Limited. Contract for supply and installation of air conditioning plant for the new tyre factory being built at Port Harcourt, Eastern Region, Nigeria, by Michelin Tyre Company Limited.

W. H. ALLEN SONS AND COMPANY LIMITED, Bedford. Order placed by Imperial Chemical Industries Limited for a 3,290-kW pass-out back-pressure turbo-alternator for installation in a chemical factory.

G.E.C. (ENGINEERING) LIMITED. Order worth over £375,000 from Dorman Long (Steel) Limited, for steelworks auxiliary drive equipment for a new blooming and slabbing mill.

THE HUNSLET ENGINE COMPANY LIMITED. Order from the Bord Na Mona (Peat Board) Ireland for 25 80 hp 0-4-0 type diesel-mechanical locomotives.

VICKERS-ARMSTRONGS (ENGINEERS) LIMITED. Orders worth more than half a million pounds have been place by Vickers for two British computors to be installed at the company's northern works. One of the orders is for the Ferranti Orion computer system and a second order is for the I.C.T. electronic data processing system.

HAMWORTHY ENGINEERING LIMITED Order for Hamworthy pumps and compressors has been received from Livanos (Shipbuilders) Limited of London for the nine ships to be built at the Yugoslav shipyards at Split and Pula. Pump and compressor equipment supplied for the first two 8000 ton cargo vessels to be built in Argentina, and for a 15,000 ton tanker for the Royal Canadian Navy.

ARTHUR LYON & CO. (ENGINEERS) LIMITED. Order from Petbow Limited for 60 revolving armature alternators.

QUALTER, HALL AND COMPANY LIMITED Barnsley. Order worth several thousand pounds placed by Dutch State Mines for a spiral chute bunker installation at Emma Colliery, near Heerlen.

THE MINISTRY OF WORKS has let contracts for the construction of an experimental nuclear reactor at East Kilbride, Scotland, for a consortium of universities (St. Andrews, Glasgow, Aberdeen, and Edinburgh Universities, the Royal College of Science and Technology at Glasgow and Queen's University, Belfast). The reactor will be made by Advanced Technology Laboratories of California in association with G. & J. Weir Limited of Glasgow. The laboratory building in which the reactor will be housed was designed by the Ministry of Works and will be erected by J. Crawford Limited of Glasgow. The capital cost of the scheme will be paid for by a grant of £255,000 from the Department of Scientific and Industrial Research to the consortium.

Business Developments

Company Acquisitions.

PARKINSON COWAN LIMITED has acquired Wild Barfield Limited and its subsidiary companies.

Trading Agreements

The former Metals Division of Imperial Chemical Industries Limited, is now an operating company— Imperial Metal Industries (Kynoch) Limited with headquarters at Kynoch Works, Witton Birmingham 6. This is a wholly-owned subsidiary of I.C.I. administered by a new holding company,

Imperial Metal Industries Limited.

TURNER AND BROWN LIMITED, chemical plant engineers, of Davenport Works, Bolton, have expanded their sales outlets considerably by a closer integration with their associate company, Matthews and Yates Limited, of Swinton, Manchester,

Agents and Distributors

TUNNY CRANES LIMITED, Victoria Street, Westminster, SW1, have appointed J. H. Plant & Co. Limited, 40, Loveday Street South, Johannesburg, as distributors in South Africa for their range of 2-ton and 3-ton lorry mounted and self-propelled hydraulically operated cranes.

THE ARGALL MACHINE TOOL COMPANY Limited, Argall Avenue, London, E10., the (Chamberlain Group of companies with headquarters at 3 Buckingham Palace Gardens, SW1.) have been appointed sole distributors throughout the United Kingdom for a new magnetic shaft seal.

NUCKEY, SCOTT & CO. LTD., of Warrior Works, Lea Valley Road, Enfield, Middlesex, have appointed Malmo Maskinaffar, Postgirokonto 14170, Sturegaten 16-18, Malmo C, as agents in Sweden for their 'Warrior' screw threading tools.

PERA Conferences and Exhibitions

THE PRODUCTION ENGINEERING RESEARCH Association of Great Britain is to hold specialized conferences and exhibitions dealing with the application of new and improved production techniques. Special emphasis will be placed at conferences and exhibitions on application of the results of PERA's research as well as the results of research and development carried out in the many overseas research organizations and industries with which PERA has established close ties. The first conference and exhibition will take place on June 27, 28 and 29, 1962, and will deal with various aspects of de-burring and metal surface preparations techniques such as vapour blasting and shot blasting. Particular attention will be given to methods of reducing production costs by the introduction of improved methods.

Materials Handling Service

TUBEWRIGHTS LIMITED, who manufacture a wide range of materials handling equipment and a subsidiary of Stewarts & Lloyds Limited, has instituted a free service to manufacturers which will enable even the smallest firm to avail itself, without charge, of the advice of a team of materials handling experts. The service is called P.E.G.—short for Project Engineering Group. After the P.E.G. team has made a survey, a report will be made containing proposals for improvements in materials handling. The service aims at giving a sound judgment and will be conducted upon a professional impartial basis.

Film News

Filmstrips: Rubber in Engineering

THE Natural Rubber Bureau has made two new filmstrips showing the tremendous diversity of the part played by rubber in engineering. One deals with mechanical engineering, and the other with civil engineering. A detailed commentary is available with each filmstrip and provides a complete accompanying lecture of about 54 minutes' to an hour's duration. The filmstrips which, with commentary, cost five shillings each may be obtained from the Natural Rubber Bureau, 19 Buckingham Street, London, WC2.

G. B. Film Library, Perivale, Middlesex, has been re-designated as Rank Film Library—part of the Cine & Photographic Division of The Rank Organization.

The World of Semiconductors. Based on the 1961 Faraday Lecture—"Transistors and all that"—which was given by AEI's director of research, Mr. L. J. Davies, this is the second scientific film made by Associated Electrical Industries. It has been made in the form of a lecture and the commentary is spoken by Mr. Davies. Like AEI's first scientific film, *Electron Microscopy* which won many awards, "*The World of Semiconductors*" has been made for the layman and senior science pupils, but it will be of interest to scientists and workers in many fields of industry. It is made in 16 mm Ektrachrome and lasts 38 minutes. Available on free loan from AEI Film Library, Crown House, Aldwych, London WC2.

A Flourish of Tubes.—A 25 min. colour film showing the main processes in the production of tube in the companies forming the Steel Tube Division of Tube Investments Limited. Available in both 35 mm. and 16 mm, the film is free on loan from either Sound Services Limited, Wilton Crescent, London SW19, or from Tube Investments Limited, T. I. House, P.O. Box 26, Birmingham 16.

Metal Cutting Exhibition

From June 4-15 inclusive, Trumpf Universal shearing, nibbling, flanging and forming machines, copy nibbling machines and the range of portable electric shearing and nibbling machines are being exhibited and demonstrated by the sole agents in the United Kingdom and Eire, F. J. Edwards Limited, at The F J E Machine Centre, Islington Park Street, London N1. The exhibition will show how these machines can be used for all kinds of sheet metal and plate cutting.

Trade Literature

Readers interested in any of the catalogues reviewed here can obtain copies by mentioning* MECHANICAL WORLD *when writing to the firms concerned.

Filter Units

Magnetic mechanical filter units for cleaning coolants, lubricants etc. of ferrous and non-ferrous contamination are the subject of a new illustrated leaflet from Rapid Magnetic Limited, Lombard Street, Birmingham 12.

Condensers and Air Pumps

A brochure and leaflet from The Mirrlees Watson Company Limited, Glasgow C5, illustrate a range of barometric condensers, various air pumps, ejectors, condensate extraction pumps and spray cooling plants.

Salt Bath Furnaces

An illustrated folder from Efco Furnaces Limited, Weybridge, Surrey, describes the Efco-Upton salt bath furnaces with concealed electrodes for hardening and tempering high speed steel.

Plastics Service

A booklet from Marley Extrusions Limited, Sevenoaks, Kent, gives details of a service for the development of products in plastics. Facilities are available for extruding, injection moulding, drape forming, PVC fabrication and film blowing.

Small Pumps

Lee, Howl & Co. Limited, Tipton, have published a comprehensive brochure in their wide range of hand and small power pumps. Hand lift, diaphragm, force, semi-rotary, test, combination, fins, bore-hole, bucket and centrifugal types are all included as well as relevant fittings and accessories.

Flame Proof Valve

A folder from Lang Pneumatic Limited Owen Road, Wolverhampton, gives sectional drawings and particulars of a flame proof solenoid valve specially for mines, refineries, chemical works etc. where there may be danger of explosion.

Mechanical Seals

A comprehensive catalogue from J. A. Cannings Limited, 25 Milsom Street, Bath, list a full range of mechanical seals for pressures up to 1000 psi, vacuum of 28 in. Hg, and surface speeds of 15 000 fpm.

Garage Tools

The new catalogue of garage tools and equipment from J. Pickavant & Co. Limited, Bows Street, Birmingham, illustrates a great many useful items which while invaluable for working on cars are ideal also for the maintenance workshop. Such things as nut splitters, wheel pullers,

Continued on next page.

bush presses, valve ginders, hand/hydraulic cylinders and panel beaters, have a very wide field of application.

Conveyor Furnaces

Leaflet No. V47 newly issued by The Medudescent Heat Company Limited, Cornwall Road, Smethwick, Birmingham, illustrates mesh belt conveyor furnace for continuous hardening and tempering.

Burners, Heaters and Fans

A leaflet from G. & R. Gilbert (Industrial) Limited, Hackbridge, Surrey, lists four fans, a gas burner and an electric heater element which have been added to the company's range of manufactures.

Vending Machines for Factories

The argument for the use of automatic vending machines in industrial premises is set out in a booklet issued by Lockhart Group Limited, 5 Tilney Street, London W1. A tabular list of machines is included.

Machine Tool Mounts

The newly developed Vulcascot Minimount is described in a leaflet issued by Vulcascot (Great Britain) Limited, 87/89 Abbey Road, London NW8. The mounts are for small workshop machines and the like, including benches which require levelling and insulating from vibration.

A New Twist Drill

The Coldpoint drill has a fluted shank with hard metal tip, central coolant conduit and negative rake. A new leaflet from Caldpoint Drills Limited, Oak Lane, East Finchley, London SW1, describes how it makes light work of drilling hard materials.

Bar, Tube and Combination Lathes

Illustrated leaflets from The Crowthorn Engineering Company Limited, Reddish, Stockport, give particulars of a new 10½ in. centre lathe for turning, boring and parting-off ferrous and non-ferrous bar and tube, and the company's 8½ in. combination turret lathe.

Magnetic Riding Gauges

A new leaflet from M. Hales & Co. Limited, 73 Devon Street, Birmingham 7, describes a range of magnetic mounts with dial gauges for riding on boring bars and the like.

Digital Tachometer

A folder from Farnell Instruments Limited, York Road, Wetherby, Yorks, describes a versatile instrument with in-line numerical read-out for shaft speed measurement or generally for timing intervals in milliseconds.

Hydraulic Pit Prop

A new illustrated folder on the Polar Prind hydraulic yielding pit prop is available from B.R.D. Company Limited, Aldridge, Staffordshire.

Relays

The new transistorized photoelectric relays now available from G.E.C. (Engineering) Limited, Witton, Birmingham, are described in publication P.1044. The new equipment incorporates a phototransistor and a transistorized amplifier.

Flaw Detector

A newly developed ultrasonic flaw detector is described and illustrated in a leaflet available from Crow, Hamilton & Co. Limited, 47 Haggs Road, Glasgow S1.

New Factories

Blyth (Northumberland). Industry Suppliers (North-East) Limited, Quay Road, Blyth ,are planning a £40,000 engineering factory at Cowpen, Blyth. The architects are Morrison and Short, 11 Clayton Road, Newcastle upon Tyne.

Carlisle. McKenzies Transport and Engineering Company Limited, are planning the erection of a vehicle repair shop and distribution depot on Willowholme industrial estate.

E. Fox Limited, motor factors, Victoria Place, Carlisle. The architects for new warehouse and offices at Lonsdale Street are Graham, Roy and Nicholson, 6 Paternoster Row.

Felling (Co. Durham). A. and M. Partners, plant hirers, West Crescent, Wardley, Felling, are proposing the erection of offices to plans by H. Fawcett, 37 Watermill Lane, Felling.

Gateshead. The Square Grip Reinforcement Company Limited, Fourth Avenue, Team Valley Trading Estate, are inquiring about land for the erection of a factory at Gateshead to employ 60 people.

Sigmund Pumps Limited. The tender of A. Monk and Company, 1a Albert Road, Middlesbrough has been accepted for further factory additions on Team Valley Estate. The architects are G. H. Gray and Partners, 8 Portland Terrace, Newcastle upon Tyne.

Tates Electronic Services. Plans are being considered for the erection of offices and warehouse on the East Gateshead industrial estate. The architect is C. Solomon, 30 St. Mary's Place, Newcastle upon Tyne.

Hebburn-on-Tyne. T. Fraser and Company Painting contractors, Ormonde Street, Jarrow, The Urban District Council have offered a site for the erection of new premises.

Middlesbrough. Road Materials (Middlesbrough) Limited, Whitehouse Garage, are seeking land at South Bank Road for the erection of a substantial office block, and premises for housing and maintaining vehicles.

Skefko Ball Bearing Company Limited. Plans are being prepared by Elliott Cox and Partners, 172 Buckingham Palace Road, London, for the erection of a sales depot at Florence Street.

Northumberland. The County Planning Committee are in touch with a firm planning a factory in South-East Northumberland which will provide work for 700 people.

Prudhoe (Northumberland). Engineering Productions (Clevedon) Limited, Clevedon, Somerset, are planning the erection of a factory at Prudhoe for making motor-car components.

Spennymoor (Co. Durham). G. and A. Gray Limited, Low Grange Road, Spennymoor. Plans are being considered for the erection of a mineral water factory. Tenders will be obtained as soon as planning approval, expected shortly, is received. The architect is F. Hedley, Farnley Hay Road, Neville's Cross, Co. Durham.

Stockton-on-Tees. Wright and Company, Skinner Street, Stockton. Plans have been approved for the erection of a mineral water factory, offices and warehouse at Skinner Street.

Sunderland. Grimshaw Leather and Company Limited, car dealers. The architects for the proposed rebuilding of workshops at Durham Road are G. T. Brown and Son, 14 Grange Terrace, Stockton Road, Sunderland.

Acton. C. G. Templer & Co. Limited, 132 Bollo Bridge Road, London W3, are to erect a new factory at Stirling Road.

Altrincham. Sidley (Machinery) Limited. New premises are to be erected in Sinderland Road.

Ayr. William Milne Limited, Falkland Road, are to erect a new factory.

Basildon. Standard Telephones & Cables Limited, Connaught House, Aldwych, are to erect a new factory at Basildon New Town.

Birkenhead. Perry Blouse Manufacturing Company Limited. Extensions are to be made to the works at Balls Road. The architects are A. Stanley Barnes and Dallow, 7 Hamilton Square.

Birmingham. Birmingham Typesetters Limited, 133 New John Street are to erect a new factory at Vauxhall Road. The architect is R. Granelli, The Rise, Birmingham Road, Hopwood.

Blackpool. Stargate Engineering Company Limited are to extend their factory at Watsons Road.

Bolton. Richard Hough Limited. Extensions are to be made to the Bowl Works, Nelson Street.

Cheltenham. F. L. Douglas (Equipment) Limited, Kingsditch Lane, Tewkesbury Road. New factory to be built at Arle Village Road. The architects are L. W. Barnard and Partners, 13 Imperial Square.

Montal Watch Fittings Limited, are to extend their works at Bouncers Lane.

Croydon. George Rose (Printers) Limited, Impress House, Church Road are to erect a new works at Zion Road.

Plastic Products Limited. A new workshop is to be built at 686 Mitcham Road.

Dover. E. M. Geysens Limited, Lorne Road. The architect for the new factory is L. R. Barlow, 32 Wilwall Place, Sandwich, Kent.

Glasgow. Gray Dunn & Co. Limited are to extend their factory at Sleads Street, Kinning Park.

Gloucester. A. E. Smith (Printers) Limited. A new factory is to be built at Eastbrook Road.

Greenwich. J. Stone & Co. (Propellers) Limited, Anchor and Hope Lane. New factory. The architects are Elliott Cox and Partners, 172 Buckingham Palace Road, London. SW1.

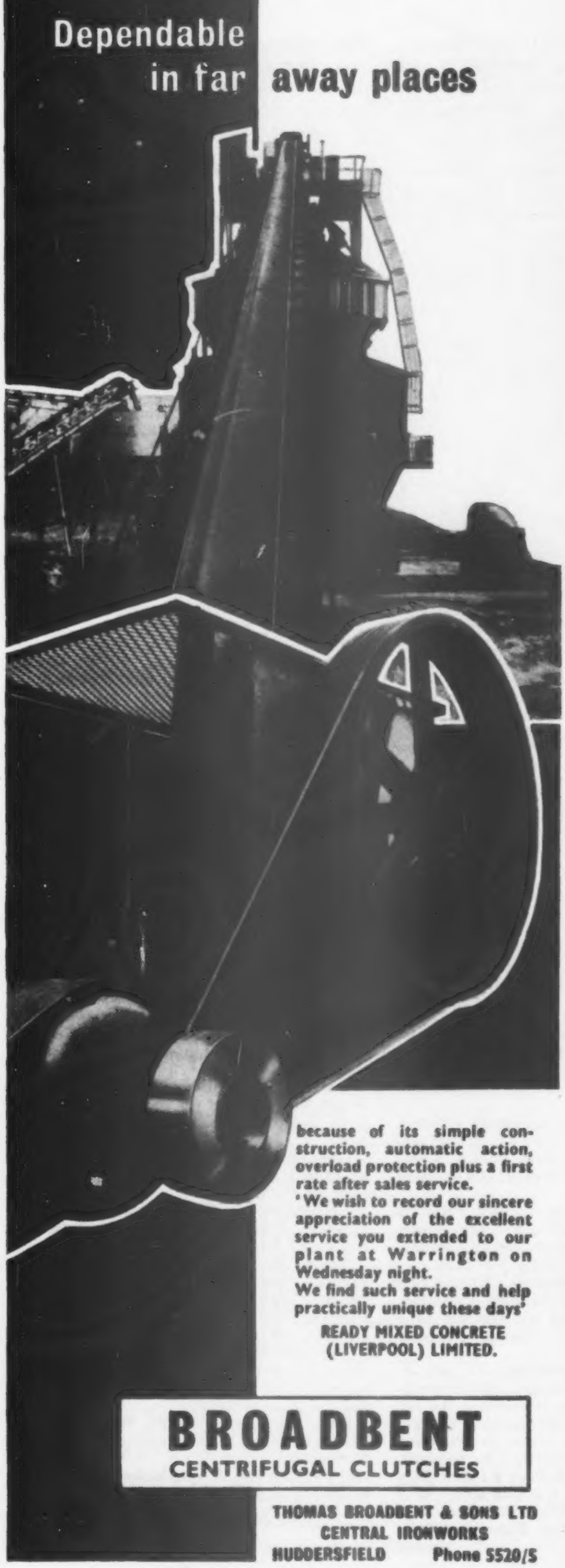
Haverhill. Koch Laboratories, 46 Britton Street, London. EC1. To lease a new factory to be erected by the U.D.C. at Bumpstead Road industrial estate.

Hull. Papropack Limited, Wyke Works, Hedon Road are to make extensions to their works.

W. A. Kirkby & Co. Reform Street. A new workshop is to be built at Park Street.

Leith. Associated British Foods Limited,

Continued on next page.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P7716

New Factories

Continued from previous page.

are to erect a new flour mill at Leith Docks.

Leominster. Cadbury Bros. Limited, Bourneville are to build a new factory at Marlbrook.

Luton. Weldability Engineering Company Limited, are to erect a new workshop at 10a Midland Road.

Macclesfield. Windsmoor (Macclesfield) Limited, New Victoria Mill. A new factory is to be erected on Hurdsfield industrial estate.

Magerafelt. James Burnside Limited, are to erect a new factory.

Manchester. Clayton Aniline Company Limited, are to extend their factory at Ashton New Road.

Mansfield. R. Jones & Co. Limited, Corporation Street. Extensions are to be made to the factory.

Hermitage Engineering (Mansfield) Limited, are to erect a new workshop at Forrest Road.

Omagh. Omagh Shirt and Collar Company Limited, are to extend their works at Kevlin Road.

Portsmouth. McMurdo Instrument Company Limited, Rodney Road, Milton. Extensions are to be made to the factory.

Drayton Engineering Company Limited, Southampton Road, Paulsgrove, are to make extensions to their factory.

Redditch. Component Metal Pressings Limited Sampson Road North, Birmingham. A new factory is to be erected at Studley Road.

Warren James Limited, The Spring Works, Arrow Road are to be extended.

Rotherham. J. J. Habershon & Sons Limited. Extensions are to be made to Planetary Mill, Steel Street.

Guest and Chrimes Limited, are to extend their factory at Don Street.

Sedgley. J. Nicholls Engineering Company. A new factory is to be built at Dormston Road industrial estate.

Sheffield. British Relay Wireless Limited, 169 Norfolk Street, are to build a new factory at Woodside Lane.

Smethwick. Guest, Keen & Nettlefolds Limited, St. George's Works, Grove Lane. Extensions are to be made to the works.

Staveley. James Smith & Co. Limited, are to extend their factory at Inkersall Road.

Swindon. Shorko Packaging (U.K.) Limited, are to erect a new factory.

Tonyrefail. Royal Worcester Ceramics Limited. Factory is to be extended.

Wakefield. British Jeffrey Diamond Limited, are to make extensions to their Standard Works.

Watford. Hills and Lacy Limited, Lincoln's Inn Field, London. WC2. are to build a new factory at Holywell industrial estate.

West Bromwich. Albion Spring Company Limited. Extensions are to be made to the works at Oldbury Road.

West Bromwich Spring Company Limited, are to extend their works at George Street.

Woolwich. T. Baybrooks & Co. Limited. A new factory is to be built at Northern Way. The architects are Higgins & Thomerson, 90, Romford Road, London. E15.

Brechin. Deeside Handloom Weavers Limited, Aberdeen, have received permission for conversion of premises in Conveners Lane, for handloom weaving textile purposes.

Carfin. Six of the seven plants vacated by the Admiralty at Carfin Industrial Estate have now been allocated to manufacturers. These are Millard Bros Limited (sports goods); S. H. Mackinnon and Company Limited (knitwear); Dunlop Rubber Company (Scotland) Limited, (assembly of tyres, wheels and tubes); Nuway Enamelling Company Limited of Birmingham (metal processing plant); Lanarkshire Education Committee (training centre).

Glasgow. Parker Mitchell Engineering Company Limited. The Board of Trade is to erect a new factory unit for this company on the Thornliebank Industrial Estate.

Yarrow & Co. Limited, Scotstoun, are to extend their engineering works to provide an additional 50,000 sq. ft. for the production of printing presses.

Markinch, Fife. Tullis Russell & Co. Limited, are to erect a new mill with Crocker, Burbank & Co. Association, Fitchburg, Mass. U.S.A. for production of special papers for the electronic industry. The plant will be jointly owned and located alongside the existing premises. It will start production in 1963.

Uphall, West Lothian. Motherwell Bridge and Engineering Company Limited, plan a factory at Uphall, producing equipment for the chemical industry. Three hundred jobs are involved.

CLASSIFIED ADVERTISEMENTS

Machinery, Plant and Accessories For Sale

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Patents For Sale or License

THE proprietor of British Patent No. 788285, entitled Improvements in Hoisting Sling, offers same for license or otherwise to ensure its practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, 770 Lexington Avenue, New York 21, New York, U.S.A.

THE Proprietors of Patent No. 743245 for "Method of and Apparatus for the Maintenance of Glass Polishing Tools", desire to secure commercial exploitation by license or otherwise in the United Kingdom. Replies to Box No. J.W. 36, 'MECHANICAL WORLD', 31, King Street West, Manchester 3.

THE Proprietor of Patent No. 768595 for "Improvements in or relating to variable pitch propeller", desires to secure commercial exploitation by license or otherwise in the United Kingdom. Replies to Box No. J.W. 37, 'MECHANICAL WORLD', 31, King Street West, Manchester, 3.

THE proprietor of British Patent No. 630142, entitled "Method and apparatus for distilling carbonaceous material", offers same for license or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, 140 So. Dearborn Street, Chicago 3, Illinois, U.S.A.

THE proprietor of British Patent Nos. 809520, 809518 and 809519, entitled "Safe torque drivers" and "Safety torque driver" and "Multi-roller safe torque drivers", offers same for license or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, 140 So. Dearborn Street, Chicago 3, Illinois, U.S.A.

THE proprietor of British Patent Nos. 809847 and 809848, entitled "Safe torque nut setter" and "Safe torque drivers" offers same for license or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, 140 So. Dearborn Street, Chicago 3, Illinois, U.S.A.

THE proprietor of British Patent No. 722922, entitled "Resilient seal gate valves", offers same for license or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, 140 So. Dearborn Street, Chicago 3, Illinois, U.S.A.

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Applications in writing quoting reference V145/1720 and giving full details, should reach the Personnel Manager, South Eastern Gas Board, Katharine Street, Croydon, within seven days.

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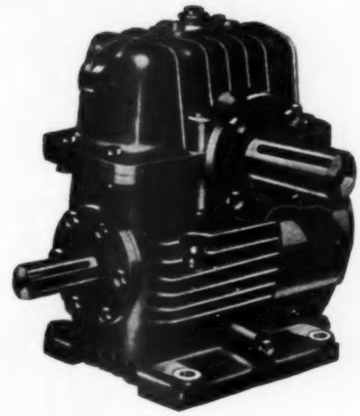

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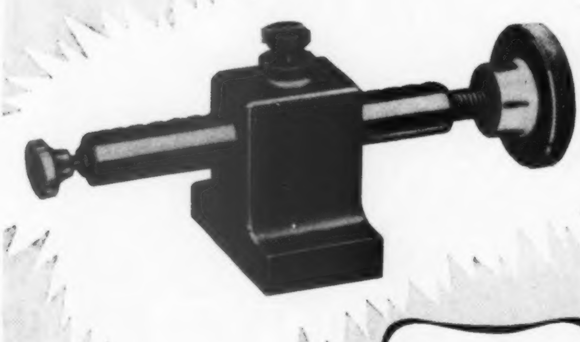

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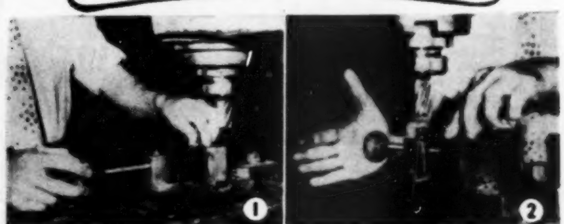

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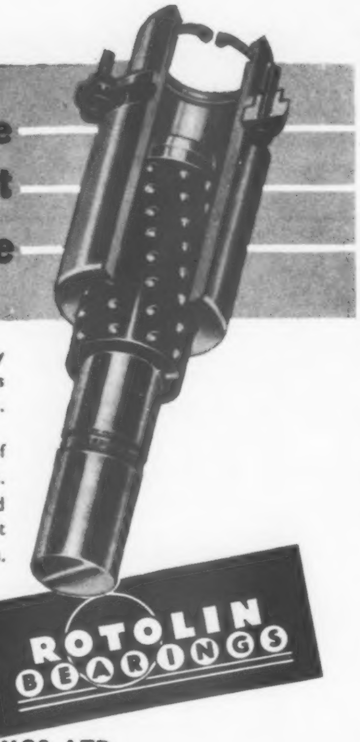

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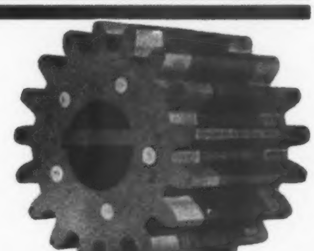

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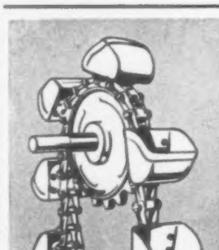

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